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Management of agri-food chains

A cross-border region where rivers connect, not divide

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Foreword

Any human activity is unthinkable without food. Food and water are the ultimate drivers of human civilization from the ancient Sumerian civilization until today. Unfortunately, today, regardless of the huge growth in food production, one of the biggest challenges of today's turbulent world is ensuring enough healthy food, which ensures not only the necessary amounts of energy and nutrients, but also to ensure the health of consumers. However, food also has numerous economic, cultural, sociological, and even religious functions or characteristics. This is the reason why production, processing, logistics, distribution, and final preparation of food are extremely complex processes, because food also ensures consumer satisfaction with its taste, appearance, colour, freshness, smell, but also with its cultural meaning. This book was created because of many years of work and research by the authors of the Hungarian University of Agriculture and Natural Sciences Campus in Kaposvár and the Križevci College of Agriculture, and it would certainly not have been created without the work on a joint project entitled as "Multilevel Education System for Agile Agri-food Chains" (acronym EDUAGRI). The purpose of the book, according to its content and concept of the chapters, is to be a common textbook for students of both related institutions, and at the same time a useful manual in which the knowledge acquired by all active stakeholders in agricultural and food chains is systematized. In explanation of certain facts and processes, both a theoretical and a practical approach were used, with real examples and their explanation.

The final success of the authors will be judged by the readers themselves, for whom the book is intended(!).

However, it should be noted that this book is one of the few that deals with the entire management of agri-food chains, particularly in the countries of Central and Eastern Europe, and is definitely the only one that is published as a trilingual edition.

Finally, this book would not have been created without the great effort and energy put into it by the authors, reviewers, translators, proof-readers, technical editors and all members of the editorial board, and it would not have been created without the financial support of the Interreg V-A cross-border cooperation program Hungary-Croatia. Thank you.

Siniša Srečec

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CHAPTER 1

Agricultural food chains

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1.1 Introduction

According to the definition that can be found in the Encyclopaedia Britannica[1], the term food means any substance that is consumed to ensure the nutritional needs of the organism. Food is usually of plant or animal origin and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins or minerals. Food is taken into the body and absorbed in the cells of the body to provide energy, sustain life or encourage growth. Based on this definition, it is quite clear that in the history of human civilization, wars were fought to conquer new areas, and thus meet the nutritional needs of certain peoples. When we talk about food, we inevitably talk about food chains. In free nature, every food chain starts with herbivores, then carnivores and finally omnivores, including man. With the domestication of wild animals and the cultivation of the first economically important plant species, the period of agriculture begins, which lasts until today. With the introduction of agriculture, man changed his way of life and the first civilizations emerged, and with the emergence of the first civilizations the first cities, the first letters and the Anthropocene period began, which lasts to this day[2] and will stop when natural resources for food production are exhausted or no longer available[3]. The development of agriculture enabled the development of other activities, because with the development of civilization, the first *agri-food chains* were formed, which enabled the division of labor. Agri-food chains connect all parts of *food systems* that have developed more or less in proportion to the increase in human population, and as one after another, various innovations in agricultural production and logistics were implemented, the world trade also grew. However, today's agricultural production is very different from agricultural production only thirty years ago. Two moments were crucial for that, one of global and economical nature and the other in the form of a natural phenomenon. Namely, in May 1986, at the G7 economic summit in Tokyo, a major problem in world food trade was noticed, and four months later the Uruguay Round of negotiations on GATT (General Agreement on Tariffs and Trade) began. General Agreement on Tariffs and Trade), which was to devise trade and agricultural policy rules, bringing world agriculture under the effective rules of the GATT[4], with all the positive but unfortunately also negative consequences for food security and adequacy in many countries. Another moment that has disrupted the accounts of GATT creators is global climate change, which inevitably affects almost all socio-economic aspects related to food systems, from agricultural and livestock production to global trade, demography and human behavior, which all together affect food security and food self-sufficiency[5]. However, a third phenomenon has recently emerged that highlights the vulnerability of agri-food chains and food systems at the state level, the COVID-19 pandemic,

which combined with global climate change is a serious threat to food security and food self-sufficiency in many countries of the world, and especially in the poorest ones[6].

1.2 What are agri-food chains and who are the stakeholders in them?

From a *socio-economic* point of view, the *agri-food chain is a system* created jointly by economic and social stakeholders involved in coordinated activities aimed at creating added value for a particular good or service, from its production to its arrival at the consumer. That chain or chains include input and service providers, processing, transportation, logistics, and other support services, such as financing. At the same time, from an *operational point of view*, the agri-food chain can be seen as an institutional tool for strategic planning, policy management, dialogue and consensus building among stakeholders or even as a social contract[7].

However, each agri-food chain has its two basic functions, namely:

a) Providing the necessary quantities of food, in order to achieve *food security* of the population of a particular country or region
b) Ensuring hygienic and healthy food, ie *food safety*, the consumption of which will not cause acute poisoning, nor chronic diseases of those who consume it.

When we talk about agri-food chains, we are talking about two forms of agri-food chains, and these are the *food value chain* and the *food supply chain*.

The food value chain is a term that refers to the movement of a food product along the supply chain and the identification of actors and their activities in order to create added value. *The food supply chain* is a process in which food reaches the end consumer, which includes all the different stages that food goes through in that process.

Understanding the agri-food chain as a food value chain is a prerequisite for the efficient management of all food production *resources*. By definition, *resources* are assets or wealth that countries, organizations, communities, or people can use to create new value or goods. Resources for food production available to a country or organization are divided into:

- *Natural resources*, including land, forests and water, and land-related assets such as soil, plants and animals.
- *Human resources* or in short people who contribute with their work, knowledge and skills create new goods, in this case food. It is natural resources that determine the possibility of providing the necessary quantities of food for the population of a country or *nutritional self-sufficiency*[8].
- *Capital resources*, ie money, infrastructure and equipment.

Unfortunately, losses inevitably occur in the food production and supply chain. It is estimated that the total losses are about 1/3 of the total food produced in the world. Unfortunately, losses in agri-food chains are higher in third world countries compared to developed countries. According to some estimates, only in the Middle East and North Africa losses in production, distribution, and losses in households and restaurants of tubers and root crops are about 26%, cereals 14 - 19%, oilseeds 16%, meat 13%, 45% fruit and vegetables, 28% fish and seafood and 18% dairy products[9].

Therefore, the management of all resources is a prerequisite for the establishment and development of sustainable food value chains[10]. Today, one of the important components of the overall management of agri-food chains is waste management in the agri-food chain[11]. Of course, all standards of hygiene and health when it comes to reusing or recycling this waste, for example in the production of animal feed must be met. In doing so, one must take into account not only the terminological but also the semantic difference between the two terms, namely *food loss* in the agri-food chain and *food waste*[12]. Namely, the term food loss refers to the reduction of the amount of food maintained in the food supply chain after harvest before it reaches the state in which it is delivered to the consumer. Food losses occur already during the harvest, and continue in all phases of transport, storage, processing of agricultural raw materials into food products, transport and storage of food products. On the other hand, food waste refers to food of adequate quality for food that is discarded before it is consumed, either at the retail outlet, or in a restaurant, or in the household of the final consumer[12].

Stakeholders in agri-food chains, from agricultural producers to the food industry, logistics and food retail chains, face major challenges, such as improving production and all business processes to ensure sufficient affordable food, and on the other foreign satisfaction of the quality of food products in accordance with the sensory preferences of consumers and the policy of overall health and hygiene of food[13]. Therefore, the conceptual framework of agri-food chain performance indicators[14] includes the following *indicators:*

- *Business efficiency* determined by cost management, profit, return on investment, value of assets and share capital.
- *Business flexibility* determined by customer satisfaction, flexibility in quantities and delivery of manufactured food products, number of withdrawn orders and late orders.
- *Business responsibility* determined by the order fulfillment rate, product delivery delays and delivery / delivery errors.
- *The quality of food* determined by the *quality of products* and the *quality of the processes* in which food products are made.

The quality of food products is determined by:

- Sensory properties of food products and shelf life.
- Hygienic and health safety of food products.
- *Reliability* or conformity of an agricultural and food product with its description and declared composition and *suitability* of a food product for use/preparation and consumption[15].

When it comes to agri-food chains in developed countries, *the main stakeholders* in this chain are *suppliers* of raw materials and equipment (both for agricultural producers and for processors of agricultural and food products), *agricultural producers* (farmers), *processors* (food industry), *distributors* (logistics), *shops* (wholesale and small shops), and finally comes the *buyer*, ie the consumer of the food product. Today, in most developed countries, the overall business efficiency of all stakeholders in the agri-food chain, measured by certain indicators, is achieved and improved by using the *Internet of Things* (IoT), ie its main component, *the blockchain*, as the main component of the system which contains all the business logics, implemented through the so-called *smart contracts* entered into the blockchain[16]. IoT and blockchain also enable complete *traceability* within the agri-food chain.

According to the FAO definition, *traceability* is the ability to distinguish, identify and track the movement of food or substances intended to be incorporated into food through all stages of production, processing and distribution[17]. Establishing traceability in the agri-food chain and the food supply chain reduces the frequency of *product recall. Product recall* is defined as the act of removing food from the market at any stage of the food chain, including that held by consumers[18]. This is the ultimate measure implemented to achieve *food safety* and consumer health. Unfortunately, every withdrawal of food products from the market creates food waste. Therefore, in developed countries, especially in EU member states, a *Farm to Fork Strategy* has been created, which includes the disposal of food waste and its use in *the circular bio-based economy*[19, 20, 21]. Thus, agri-food chains, in terms of specifics that may relate to the type of product and/or the method of production and the number of stakeholders, become components of *food systems*. Although there is no single definition of food systems[22], they are determined by a range of activities carried out on the establishment of agri-food chains, food security activities and other activities such as environmental protection and biodiversity[23, 24].

1.3 Characteristics of conventional and organic agricultural production according to food properties

Organic agriculture is determined by basic principles such as health, ecology, equity and care for the environment, animals and food consumers[25]. The key principle of organic agricultural production, also called organic farming in Europe, is that only healthy ecological systems can promote the development and sustainability of agriculture[26]. On the other hand, conventional agricultural production systems, which involve intensive cultivation and intensive use of pesticides and mineral fertilizers, tend to impair soil health as they lead to its poor biological, chemical and physical properties[27]. With the increase in environmental

awareness, the consumption of organic or ecological food is growing more and more, especially in the highly developed countries of the northern hemisphere, primarily in the EU[28]. The best and most precise definition of organic agricultural production is given in EU Regulation 2018/848 of 30 May 2018[29] and it reads:

"Organic production is a complete system of farm management and food production that combines the best environment of mental and climate action practices, high levels of biodiversity, conservation of natural resources and the application of high animal welfare standards and high production standards in line with growing consumer demand for products natural substances and processes. Organic production thus plays a dual social role, where, on the one hand, it provides a specific market that suits consumers, demand for organic products, and on the other hand delivers publicly available goods that contribute to environmental protection and animal welfare, as well as rural development.

From the preamble of that document, which sets out the basic definition of organic production, it is clear that the terms organic and ecological production are essentially synonymous. This very comprehensive document specifies all the measures and procedures that are allowed in organic food production and clearly defines the measures and procedures that may be implemented in all aspects of organic/ecological food production. It also defines the concept of welfare of domestic animals and bees, reduction and even ban on the use of agrochemicals, especially pesticides and mineral fertilizers, etc.

Unlike organic, conventional agricultural production is a classic agricultural production, exclusively market-oriented, highly intensive, involves the use of pesticides that are allowed for use and the use of GMOs. Propagators of organic agriculture often point out many shortcomings of conventional, industrial and agricultural practices. They require a number of benefits allegedly provided by organic farming. Namely, organic agriculture eliminates chronic and acute exposure to toxic pesticides among agricultural workers, consumers, as well as surrounding aquatic and terrestrial ecosystems. Organic products have higher nutritional value with higher content of vitamins and minerals. It is also claimed that organic products taste better due to higher sugar content, and last longer due to high metabolic integrity and superior cellular structure. Organic cultivation maintains soil health and encourages the development of soil microorganisms, thus facilitating the availability of nutrients to plants. In organic agriculture, mutations that lead to insect resistance to some of the widely used insecticides are reduced. In addition, by reducing the cost of many inputs – including insecticides, herbicides and synthetic fertilizers - organic farming costs less and is economically competitive. Finally, relying on the inputs that exist in nature, organic agriculture offers a more harmonious orientation towards the natural world and as such represents a desirable ethical strategy for humanity. The fact is that some of these claims have been confirmed. In particular, the results of 12 out of 15 meta-analyzes confirm that agricultural products produced in organic agriculture contain more antioxidants, vitamin C and Ω-3 fatty acids than those produced in conventional production. On the other hand, it is an indisputable fact that yields in organic agriculture are up to 34% lower compared to conventional[30, 31].

The question is, can organic farming reduce vulnerability and strengthen the resilience of the European food system?[32]. The answer is simple, not in itself, because none of the appropriate food production strategies need full implementation, but their combined implementation brings sustainable food production and meets the nutritional needs of the population[33]. Namely, the development and wider application of information technologies such as *machine learning (ML)* and the development and application of *artificial intelligence (AI)* in conventional agriculture greatly reduces the use of mineral fertilizers by increasing their effectiveness[34, 35]. In this way, conventional agriculture is transformed into *precision agriculture*[36] in which equal fertilization with mineral fertilizers and application of phytopharmaceutical preparations is not performed on all parts of the production area, but it is carried out selectively according to actual treatment that a certain part of production area needs. In this way, the intake of harmful substances into both soil and crops is reduced and soil contamination and accumulation of residues in agricultural products are greatly reduced.

The main specifics of organic/ecological food production compared to conventional[13] are the following:

- prohibition of the use of GMO seeds,
- prohibition of the use of mineral fertilizers,
- prohibition of the use of synthetic pesticides,
- prohibition of the use of growth promoters,
- maximum allowable annual amount of nitrogen in organic fertilizers of 170 kg N/ha.

Therefore, organic/ecological agricultural production has a clearly defined system of control and certification of agricultural products of organic/ecological origin[29], and *it is necessary to ensure that mixing and processing of organic products after harvest does not interfere with conventional agricultural products.* Otherwise, it will not be possible to ensure traceability in the agri-food chain of organic/ecological products, and thus food products will not meet *the compliance criteria*, which is why they will not be labeled as organic/ecological[37].

1.4 Post-harvest management of agricultural products in agri-food chains

Post-harvest management of technological products is carried out in order to meet quality standards for fresh and processed products in order to meet the prescribed quality standards for agricultural and food products[38] and preserve their shelf life[39]. Therefore, post-harvest management of agricultural products in agri-food chains is an integral part of the overall food *value chain* of a particular agricultural product on the way from the farm to the consumer's table[40].

Post-harvest management measures for agricultural products vary depending on the type of agricultural product. However, depending on the storage conditions of agricultural products after harvest, the texture, taste, color and nutritional composition of a particular agricultural product may change. These changes can progress even to the complete deterioration of certain agricultural products and food products in the further stages of agri-food chains. Spoilage is essentially a process in which all the properties of food quality deteriorate to a level that makes that agricultural or food product inedible for human or domestic consumption[40]. The causes of such spoilage can be:

- harmful microorganisms, which in inadequate storage conditions lead to contamination by bacteria and mold;
- storage pests, most often insects and mites;
- rodents and birds.

Cereal crop products of cereals and legumes after harvest go through the following stages:

3. Transport from the field to the silo.
4. Cleaning the batch of granular field product from post-harvest residues of chaff, spindle, pods, remnants of stems and seeds of weeds, dust, etc.
5. Drying of a batch of granular product (if necessary) in flow dryers[41].
6. Cool the batch of granular product after drying.
7. Charging silo cells.
8. Storage and monitoring of granular field product in silo cells during storage.
9. Exclusion of a batch of granular agricultural product from silo cells and transport to the processor, ie the mill industry and the feed industry.

However, it should be noted that due to the specifics of organic/ecological agricultural production, farmers are greatly limited in the application of storage pest control measures. Physical methods of storing storage pests such as the use of CO_2 and/or inducing low temperatures in silos that do not favor the development and reproduction of storage pests are most commonly used[42, 43], while chemical methods of controlling storage pests may be used in storage of granular products, produced in conventional breeding.

In fruit and vegetable production, post-harvest management includes:

- cleaning,
- washing,
- selection,
- ranking,
- disinfection,
- storage of batches of agricultural products most often in ULO (*ultralow oxygen*) cold stores[44],
- packaging and transport to consumers,
- or drying or deep freezing, and packaging of dried or frozen product and transport to consumers.

Also, in the preparation of fruits and vegetables for the storage process as well as during storage, mixing of

lots of fruits and vegetables produced in organic or conventional cultivation may also occur.

It should be noted that during post-harvest food management, most of the food losses in the production-process agri-food chain occur. These losses refer not only to losses of certain quality properties[38, 39], but also to quantity. Losses in the quantity/weight of granular agricultural products occur most often during the transport of agricultural products and in the case of poorly implemented monitoring measures of stored agricultural products, resulting in contamination of stored agricultural products with mycotoxins. Losses in the amount of agricultural products relate to the breaking of cereal grains and legumes, or to the sludge or loss of water in fruits and vegetables. However, mycotoxin contamination is a growing problem these days. Namely, depending on the conditions during the vegetation of a particular crop or plantation that may favor the development of harmful fungi, most often species of the genus *Fusarium* and *Apergillus*, there is the formation of their secondary metabolites called mycotoxins. Mycotoxins have a bad effect on the health of humans and domestic animals and can often cause acute poisoning in animals and also chronic poisoning in humans. Through the food chain from plant foods and products of animal origin mycotoxins end up in the human diet because *the mycotoxicological chain completely coincides with the food chain*[45]. However, proper post-harvest management, which includes analysis of batches of agricultural products coming from the field, prevention measures and the application of modern technological measures for successful storage of agricultural products, preventing the development of pathogenic fungi of *Fusarium* and *Apergillus*, the amount of mycotoxins can be reduced[46, 47, 48].

Therefore, post-harvest management in the agri-food chain is extremely important for ensuring hygienic and healthy food, for reducing food losses and thus for achieving business efficiency, because every loss of food inevitably means financial loss in the food value chain.

1.5 Animal welfare in the agri-food chain

Animal welfare has lasted since the domestication of domestic animals until today, and its basic intention has never changed. Animal welfare can be defined as the state of domestic animals without:

- pain,
- suffering
- and stress[49].

On the protection of animals kept for production purposes, the Council of the European Union in 1998 adopted Directive no. 98/58/EC on the protection of animals kept for agricultural production [50], and also the conditions for keeping and feeding animals are clearly described in the already mentioned European Commission Regulation no. 889/2008 on organic production[37].

Animal welfare is assessed on the basis of the following parameters:

- It is evident that the animals have access to water and food and are not malnourished.
- The animals have adequate housing conditions and the number of animals per unit of floor area does not exceed the prescribed limits.
- Animals have good veterinary care and prevention measures are implemented, and if necessary, treatments for injuries and treatment of diseases.
- Animals have enough space and adequate conditions to manifest their normal forms of behavior.
- Animals do not show fear of humans.

As already mentioned, animal welfare is of paramount importance in organic/ecological production[37]. However, it is given great importance also in conventional livestock production, entirely for economic reasons, ie to reduce losses such as animal deaths or transport to unplanned slaughter. Unfortunately, some livestock producers will not increase animal welfare, even if the lack of animal welfare directly causes losses in production[51]. However, depending on government legislation and customer requirements, large conventional farms will invest in animal welfare [52]. In particular, if stress conditions occur during animal loading, transport, and if animals do not recover adequately before slaughter, meat quality declines greatly as animal blood stress indicators increase, resulting in decreased muscle glycogen reserves and increased pH value[53].

One of the great challenges for conventional animal husbandry is the restriction of the use of antibiotics,

ie their complete ban on their addition in the process of animal feed production[54]. Namely, since Sir Alexander Fleming discovered penicillin from 1937 until today, the consumption of antibiotics has been growing exponentially, and the consequence of this is the emergence of microbial resistance to antibiotics. Namely, for decades, antibiotics have been used as feed additives, which has led to the resistance of many pathogenic bacteria to them, and through animal products (meat, milk and eggs) antibiotics have accumulated in humans, resulting in the emergence of resistance of certain strains of pathogenic bacteria in the human population[55].

Examples of antibiotic resistance and the mycotoxicological chain best illustrate the importance of the link between the agri-food chain and food safety.

1.6 Traceability in the agri-food chain

There are several definitions of *traceability*, which refer to different types of raw materials, additives, food products, or processes[56]:

- *Lot traceability* involves identifying the lot and determining its origin (eg country of origin, location of producers and quantities) as well as tracking all information about the material (eg 'where' and 'where it is used'). The traceability of the batch strictly corresponds to the production costs and is easy to establish by following not only the product and/or raw material declarations, but also the incoming invoices, delivery notes, customs declarations and other documentation.
- *Food traceability* can be defined as a set of all the information necessary to know the history of the production of a particular food and to know each stage of the transformation that food has gone through from the grower to the consumer's table (from farm to fork).
- *Traceability* involves the monitoring of food, animal feed, food of animal origin and all substances through all stages of production and distribution.
- *Traceability* is the ability to track the movement of a food product and its ingredients up and down the food chain to prevent unsafe food from reaching consumers[57].

In order for traceability to be successfully implemented, certain minimum requirements need to be met:

1. Identification of food business operators;

Namely, at the time of submitting an application for registration of food business for domestic or imported food, in accordance with the Food Safety Act, the food business entity must include the following information relevant to traceability, among other application requirements that may be prescribed:

- name of the food business operator and contact details,
- information on the identification and registration of the company,
- name and contact details of the person responsible for traceability,
- address and telephone numbers of all locations registered within the business,
- shelf life or product shelf life,
- methods of preserving and storing products,
- country of origin, in the case of imported food,
- manufacturer or exporter in the case of imported food,
- food traceability management plan of the food business operator.

Furthermore, each food business operator shall keep records to identify any party that has supplied the food business operator or to which the food business operator supplies food or any substance intended to be incorporated into the food business, and shall provide information for persons in charge of monitoring the traceability of food to the competent authority.

2. Identification and marking;

Food business operators need to determine what needs to be monitored. This is usually called a *traceable item / unit.* The following item can be:

- packaged product or item being traded (eg box / carton, consumer item),
- logistics unit (eg bucket, container),

- the shipment or movement of a product or trade item.

All traceable items must have a label affixed to the package with the following information in the latest, most accurate and legible form:

- food business identification number and brand name,
- a description of the type of article according to the brand name (if applicable) and according to the specific variety (eg brand: Trappist cheese, not only cheese; Roma salad, not only lettuce),
- product manufacturer, producer or processor,
- lot/batch number,
- code to indicate the date, as required by relevant legislation (eg best by, harvest, packaging, production or expiry date) and
- quantity.

3. Preservation of documentation;

All documentation involving the sale or transfer of a traceable unit must contain the following information:

- name and contact details of the supplier or customer or trading partner, including the food business identification number,
- a description of the traceable item, including the brand name, where applicable, and the specific variety or type of food,
- the batch or batch number or other specific identifier of the traceable unit, including the date of harvest or the standard bar code for products intended for retail sale,
- quantity and packaging information,
- price per unit or weight.
- date of business transaction.

4. Chain of custody[1]

Traceability system has to:

- enable identification of the product by product ID, batch/series and relationship to identification and batch / serial number of ingredients, raw materials and packaging in direct contact with food or packaging intended or expected to be in direct contact with food;
- be able to be tracked from the customer through all stages of processing to the supplier of ingredients, raw materials and primary packaging materials, including transport;
- be able to be tracked from suppliers of ingredients, raw materials and primary packaging material through all stages of processing to the customer, including transport.

Finally, if any non-compliance is identified in the agri-food chain, the last and most drastic phases follow, and that is.

5. Product recall

Product recall is performed according to the Product Withdrawal Strategy, which contains the following elements:

- the level of recall, which can be at the level of wholesale, retail or even households,
- the content of the public notices to be issued depending on the classification and the seriousness of the reasons for the recall,
- in emergencies, a public warning issued across the country or affected geographical areas,
- the level of verification of effectiveness, which includes the method to be used to verify the effectiveness of in – depth recall and
- disposal of withdrawn products.

The following factors must be taken into account when designing any product recall strategy:

[1] According to ISO 22095 - The storage chain is described as "a simple solution" designed "to increase the confidence of producers and consumers, reduce supply chain costs by addressing issues such as risk, loss of time and production conditions." Link: https://www.iso.org/news/ref2574.html

- health risk assessment,
- type or use of the product,
- ease of product identification,
- the degree to which the lack of product is obvious to the consumer or user,
- the amount of product that remains unused on the market,
- distribution schedule and
- constant availability of basic products to consumers, in order to reduce the negative consequences through a drop in demand for the product in question.

Finally, it is quite clear that the traceability system is based on the entire consumer safety of a particular food product in the agri-food production and distribution chain, and the value chain, as described in ch. 1.2.

Bibliography

[1] Britannica, The Editors of Encyclopaedia. Food. Encyclopedia Britannica, Accessed 13 August 2021. https://www.britannica.com/topic/food.

[2] Tauger, M. B. (2020) Agriculture in World History. 2nd Edition. Routledge & CRC Press, Taylor & Francis Group.

[3] Herrington, G. (2020) Update to limits to growth. Comparing the World3 model with empirical data. Journal of Industrial Ecology, 25(3), 614–626. https://doi.org/10.1111/jiec.13084.

[4] Watkins, K. (1991) Agriculture and food security in the GATT Uruguay round. Review of African Political Economy, 18(50), 38–50. https://doi.org/10.1080/03056249108703887.

[5] Tirado, M. C., Clarke, R., Jaykus, L. A., McQuatters-Gollop, A., Frank, J. M. (2010) Climate change and food safety: A review. Food Research International, 43(7), 1745–1765. DOI: https://doi.org/10.1016/j.foodres.2010.07.003

[6] Cullen, M. T. (2020) COVID-19 and the risk to food supply chains: How to respond? FAO, Rome. https://doi.org/10.4060/ca8388en.

[7] Garcia-Winder, M., Riveros, H., Pavez, I., Rodriguez, D., Lam, F., Arias, J., Herrera, D. (2009) Agrifood chains: a tool for strengthening the institutional framework of the agricultural and rural sector. Com. Inter-American Institute for Cooperation on Agriculture, May-August 2009, 26–38. http://repiica.iica.int/docs/B1617i/B1617i.pdf

[8] Habimana Nyirasafari, G. (1987) The concept of nutritional self-sufficiency and the demographic equilibrium of Rwanda. Imbonezamuryango, 10, 4–14.

[9] Ghamrawy, M. (2019) Food loss and waste and value chains – Learning guide. FAO, Cairo. http://www.fao.org/3/ca5312en/ca5312en.pdf

[10] Neven, D. (2014) Developing sustainable food value chains – Guiding principles. FAO, Rome. http://www.fao.org/3/i3953e/i3953e.pdf

[11] Mu'azu, N. D., Blaisi, N. I., Naji, A. A., Abdel-Magid, I. M., AlQahtany, A. (2019) Food waste management current practices and sustainable future approaches: a Saudi Arabian perspectives. Journal of Material Cycles and Waste Management, 21, 678–690. https://doi.org/10.1007/s10163-018-0808-4.

[12] Kennard, N. J. (2019) Food Waste Management. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Zero Hunger. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-69626-3_86-1.

[13] Knura, S., Gymnich, S., Rembialkowska, E., Petersen, B. (2007) Agri-food production In: Luning, P. A., Devlieghere, F., Verhé, R. (eds.). Safety in the agri-food chain. Wageningen Academic Publishers. The Netherlands. pp. 19–65.

[14] Aramyan, L., Ondersteijn, C., van Kooten, O., Lansink, A. O. (2006). Performance indicators in agri-food production chains. In: C. J. M., Wijnands, J. H. M., Huirne, R. B. M., van Kooten, O. (eds) Quantifying the agri-food supply chain. Ondersteijn. Springer Science, Business Media, pp. 47–64. https://doi.org/10.1007/1-4020-4693-6_5

[15] Caro, M. P., Ali, M. S., Vecchio, M., Giaffreda, R. (2018) Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. 2018 IoT Vertical and Topical Summit on Agriculture – Tuscany (IOT Tuscany), Tuscany, 2018, 1–4. https://doi.org/10.1109/IOT-TUSCANY.2018.8373021.

[16] FAO (2017) Food Traceability Guidance. Pp 140. FAO, Santiago. http://www.fao.org/3/i7665e/i7665e.pdf

[17] EC (2020) A Farmo to Fork Strategy for a fair, healthy and environmentally-friendly food system. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2020) 381 final. Brussels. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381

[18] Uo.

[19] EU (2020) Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. https://ec.europa.eu/food/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf

[20] Uo.

[21] Sadhukhan, J., Dugmore, T.J.I, Matharu, A., Martinez-Hernandez, E., Aburto, J., Rahman, P. K. S. M., Lynch, J. (2020) Perspectives on „Game Changer" Global Challenges for Sustainable 21st Century: Plant-Based Diet, Unavoidable Food Waste Biorefining, and Circular Economy. Sustainability, 12, 1976. https://doi.org/10.3390/su12051976.

[22] Brouwer, I. D., McDermott, J., Ruben, R. (2020) Food systems everywhere: Improving relevance in practice. Global Food Security, 26, 100398. https://doi.org/10.1016/j.gfs.2020.100398.

[23] UNEP (2016) Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., Hajer M. https://www.resourcepanel.org/reports/food-systems-and-natural-resources

[24] Stefanovic, L., Freytag-Leyer, B., Kahl., J. (2020) Food System Outcomes: An Overview and the Contribution to Food Systems Transformation. Frontiers in Sustainable Food Systems, 4, 546167. https://doi.org/10.3389/fsufs.2020.546167

[25] Brandt, K. (2007) Issues paper: organic agriculture and food utilization. International Conference on Organic Agriculture and Food Security, FAO, Rome, 3–5 May, 2007. http://www.fao.org/3/ah951e/ah951e.pdf
[26] FAO (2021) Organic foods – Are they safer? Food safety technical toolkit for Asia and the Pacific. No. 6. Bangkok. http://www.fao.org/3/cb2870en/cb2870en.pdf
[27] Arriaga, F. J., Guzman, J., Lowery, B. (2017) Conventional Agricultural Production Systems and Soil Functions. In: Al-Kaisi, M. M., Lowery, B. (eds.). Soil Health and Intensification of Agroecosytems. Academic Press, Elsevier. pp. 109–125. https://doi.org/10.1016/B978-0-12-805317-1.00005-1
[28] Gomiero, T. (2018) Food quality assessment in organic vs. conventional agricultural produce: Findings and issues. Applied Soil Ecology, 123, 714–728. https://doi.org/10.1016/j.apsoil.2017.10.014
[29] European Parliament and The Council of the European Union (2018) Regulation (EU) 2018/848 of The European Parliament and of The Council 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007. Official Journal of the European Union, L 150. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0848&-from=MT
[30] Borel, B. (2017) When the Pesitcides Run Out. Nature, 543, 302–304. https://doi.org/10.1038/543302a
[31] Tal, A. (2018) Making Conventional Agriculture Environmentally Friendly: Moving beyond the Glorification of Organic Agriculture and the Demonization of Conventional Agriculture. Sustainability, 10, 1078. https://doi.org/10.3390/su10041078
[32] Brzezina, N., Kopainsky, B., Mathijs, E. (2016) Can Organic Farming Reduce Vulnerabilities and Enhance the Resilience of the European Food System? A Critical Assessment Using System Dynamics Structural Thinking Tools. Sustainability, 8, 971; https://doi.org/10.3390/su8100971
[33] Muller, A., Schader, C., Scialabba, N. E. H., Brüggemann, J., Isensee, A., Erb, K., Smith, P., Klocke, P., Leiber, F., Stolze, M., Niggli, U. (2017) Strategies for feeding the world more sustainably with organic agriculture. Nature Communications, 8, 1290. https://doi.org/10.1038/s41467-017-01410-w
[34] Liakos, K. G., Busato, P., Moshou, D., Pearson, S., Bochtis, D. (2018) Machine Learning in Agriculture: A Review. Sensors, 18, 2674. https://doi.org/10.3390/s18082674
[35] Xu, J., Guo, S., Xie, D., Yan, Y. (2020) Blockchain: A new safeguard for agri-foods. Artificial Intelligence in Agriculture, 4, 153–161. https://doi.org/10.1016/j.aiia.2020.08.002
[36] Cisternas, I, Velásquez, I., Caro, A., Rodríguez, A. (2020) Systematic literature review of implementations of precision agriculture. Computers and Electronics in Agriculture, 176, 105626. DOI: https://doi.org/10.1016/j.compag.2020.105626
[37] Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control. http://data.europa.eu/eli/reg/2008/889/2021-01-01
[38] El-Ramady, H. R., Domokos-Szabolcsy, E., Abdalla, N. A., Taha, H. S., Fári, M. (2015) Postharvest Management of Fruits and Vegetables Storage. In: Lichtfouse E. (eds) Sustainable Agriculture Reviews. Sustainable Agriculture Reviews, 15. https://doi.org/10.1007/978-3-319-09132-7_2
[39] Tanner, D. (2016) Impacts of Storage on Food Quality. Reference Module in Food Sciences. Elsevier. DOI: http://dx.doi.org/10.1016/B978-0-08-100596-5.03479-X
[40] Dent, B., Macharia, J., Aloyce, A. (2017) Value Chain Thinking: A Trainer's Manual. World Vegetable Center, Shanhua, Taiwan. Publication. https://avrdc.org/download/publications/from_the_field/agribusiness-value-chains/Value-Chain-training-manual_final_web.pdf
[41] Bomford, P. H., Langley, A. (2003) Grain preservation and storage. In: Soffe, R. (ed.). The Agricultural Notebook (20th Edition). Primrose McConnell's, Blackwell Science & Blackwell Publishing. pp. 231–246.
[42] Riudavets, J., Castañé, C., Alomar, O., Pons, M. J., Gabarra, R. (2010) The use of carbon dioxide at high pressure to control nine stored-product pests. Journal of Stored Products Research, 46, 228–233. https://doi.org/10.1016/j.jspr.2010.05.005
[43] Mišan, A., Mandić, A., Hadnađev, T. D., Filipčev, B. (2020) Healthy Grain Products. In: Pojić, M., Tiwari, U. (eds.). Innovative Processing Technologies for Healthy Grains. Wiley. pp. 83–111. https://doi.org/10.1002/9781119470182.ch5
[44] Thewes, F. R., Both, V., Brackmann, A., Weber, A., Anesea, R. O. (2015) Dynamic controlled atmosphere and ultralow oxygen storage on 'Gala' mutants quality maintenance. Food Chemistry, 188(1), 62–70. https://doi.org/10.1016/j.foodchem.2015.04.128
[45] Ráduly, Z., Szabó, L., Madar, A., Pócsi, I. Csernoch, L. (2020). Toxicological and Medical Aspects of Aspergillus-Derived Mycotoxins Entering the Feed and Food Chain. Frontiers in Microbiology, 10, 2908. https://doi.org/10.3389/fmicb.2019.02908
[46] Schaarschmidt, S., Fauhl-Hassek, C. (2020) The fate ofmycotoxins during secondary food processing of maize for human consumption. Comprehensive Reviews In Food Science And Food Safety, 20, 91–148. https://doi.org/10.1111/1541-4337.12657
[47] Srečec, S., Štefanec, J., Pleadin, J., Bauman, I. (2013) Decreasing deoxynivalenol concentration in maize within the production chain of animal feed. Agro Food Industry Hi Tech, 24, 62–64.
[48] Magan, N., Aldred, D. (2007) Post-harvest control strategies: Minimizing mycotoxins in the food chain. International Journal of Food Microbiology, 119, 131–139. https://doi.org/10.1016/j.ijfoodmicro.2007.07.034
[49] Eddison, J. C. (2003) Animal welfare. In: Soffe, R. (ed.). The Agricultural Notebook (20th Edition). Primrose McConnell's, Blackwell Science & Blackwell Publishing. pp. 431–440.
[50] Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes. (OJ L 221, 8.8.1998, p. 23). http://data.europa.eu/eli/dir/1998/58/2019-12-14
[51] Lusk, J. L., Norwood, F. B. (2011) Animal Welfare Economics. Applied Economic Perspectives and Policy, 33, 463–483. https://doi.org/10.1093/aepp/ppr036
[52] Grethe, H. (2017) The Economics of Farm Animal Welfare. Annual Review Of Resource Economics, 9, 75–94. https://doi.org/10.1146/annurev-resource-100516-053419
[53] Gallo, C., Taruman, J., Larrondo, C. (2018) Main Factors Affecting Animal Welfare and Meat Quality in Lambs for Slaughter in Chile. Animals, 8, 165. https://doi.org/10.3390/ani8100165
[54] Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition. http://data.europa.eu/eli/reg/2003/1831/oj

[55] Kirchhelle, C. (2018) Pharming animals: a global history of antibiotics in food production (1935–2017). Palgrave Communications, 4, 96. https://doi.org/10.1057/s41599-018-0152-2
[56] Trienekens, J., van der Vorst, J. (2007) Trraceability in food supply chain. In: Luning, P. A., Devlieghere, F., Verhé, R. (eds.). Safety in the agri-food chain. Wageningen Academic Publishers. The Netherlands. pp. 439–470.
[57] Millard, P., Paine, S., O'Hagan, S., Hipkiss, J. (2015) Traceability of allergenic foods in the food chain. In: Handbook of Food Allergen Detection and Control. Flanagan, S. (ed.). Woodhead Publishing, Elsevier. 19–40. https://doi.org/10.1016/C2013-0-16428-8

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CHAPTER 2

Agri-Food Supply Chains Design and Management

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This chapter presents the basic concepts of the agri-food supply chain, taking into account the specifics of this chain. The chapter includes questions such as: What is an agri-food supply chain? What is agri-food supply chain management and why is it important? It provides information on how an agri-food supply chain can be structured and what the specifics of each type of chain are. It also identifies who are the actors (stakeholders, members) of the agri-food supply chain, their roles and main activities in each agri-food supply chain.

2.1 Introduction to Agri-Food Supply Chains

In the Croatian language, the term Supply Chain (SC) is of relatively recent origin and today in the literature various synonyms are used for this term such as: supply chain, supply chain, supply chain, etc., depending on the author, the problem research and the observed sector. There are extensive analyzes and numerous definitions of the supply chain in the scientific literature. Waters[1] states that the supply chain consists of a series of activities and organizations through which materials pass on their way from the initial supplier to the end customer. The author defines materials as all things that a company runs to create its product, so it distinguishes between tangible materials (raw materials or semi-finished products) and intangible materials (for example, information). Furthermore, Waters defines both upstream and downstream activities in the supply chain (Figure 1).

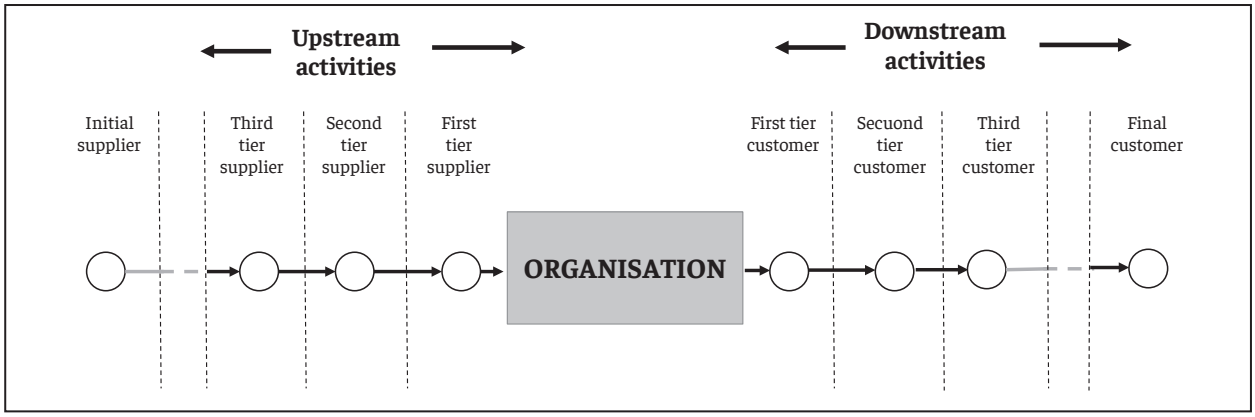

Figure 1. *Supply chain activities . Source: Waters [1]*

Thus, upstream activities represent all those activities by which materials are launched towards the company, ie all activities performed by companies that are in the supply chain before the observed company. These are mainly suppliers (first order suppliers, second order suppliers and so on). While downstream activities in the supply chain include all activities by which materials move from the observed company, ie, all activities performed by companies that are in the supply chain after the observed company, it is mostly customers who can also be divided into first tier customers, second tier customers and so on to the end consumer.

Agri-Food Supply Chain – AFSC starts from the primary producer (organization or individual engaged in agriculture), and the food product obtained at this stage moves through various processing methods, distribution, storage and other processesing activities before reaching the end consumer. Agri-food supply chains, as well as supply chains of other types of products are networks of interconnected economic entities working together to convert goods and distribute these goods from raw materials to the final product and meet customer/consumer requirements[2, 3].

AFSC geographically covers all areas of food chains with its specifics: local, regional, national and international. They are constantly evolving from simple, which were initially categorized as commercial, competitive or simply customer-supplier relationships to the present day increasingly complex relationships between a growing number of actors in the food chain. Today, AFSC strives for long-term, quality cooperation with an emphasis on food quality with greater traceability and agility in order to achieve increasing consumer satisfaction while achieving a competitive advantage and sustainability of the food supply chain.

AFSCs operate in a complex, dynamic environment at a time where product quality is vital. Bourlakis and Weightman[4] describe six key factors that play a significant role in the evolution and development of modern food supply chains. These are: quality, production technology, logistics, information technology, legislative (regulatory) framework and consumers.

2.1.1 Defining Agri-Food Supply Chain

One of the first AFSC models was offered by the first experts to explore the role and potential of Food Supply Chains – FSC in the rural development process[5], while the management of agri-food supply chains (Agri-Food Supply Chain Mangement – AFSCM) was first defined by a group of Dutch scientists[6, 7]. Subsequently, a number of scholars and practitioners changed or adapted the definition of the AFSC with regard to: the academic background of the author, the research topic, the sector being researched/analyzed (eg food industry, retail, family farms, etc.), the number and the type of stakeholders involved (eg short / long or direct / indirect chains) or specific processes of a particular chain (eg organic production), types of products (eg fresh or processed), etc.[8, 9, 10].

Accordingly, different terminology for AFSC is used, especially in the English-speaking world. Some of the premieres are: Food Chain FC; Food supply chain management (FSCM); Food Industry FI; Agri food chain AFC; Agricultural Supply Chain (ASC); Agri-Food SupplyCchain Management AFSCM; Agri-food supply chain networks (AFSCN); Fresh produce supply chain management (FPSCM); Perishable food supply chain quality (PFSCQ) and others.

It can be concluded that there is no generally accepted definition of an agri-food supply chain or han supply chain. Some examples of definitions are:

"Agricultural supply chain (ASC) is a supply chain of products of agricultural origin"[11].

"The food supply chain (FSC) involves the direct exchange of food from farmers to consumers or various stages of activities, such as processing raw agricultural products, as well as checking consumer safety standards and packaging or transport activities that add value to food before it is sold."[12].

"The agri-food supply chain (AFSC) is a set of" farm to fork "activities, including agriculture (ie tillage and crop production), processing / production, testing, packaging, storage, transport, distribution and marketing"[8].

"The food supply chain (FSC) is a sequence of operations that takes care of the perishable nature of products, large fluctuations in demand and prices, increased consumer concerns about food safety and dependence on climate conditions"[13].

"FSC is defined as the processes from production to consumption of fresh products (fruits, flowers and vegetables)."[14]

"FSC is defined as a large variety of products and companies that operate in different markets and sell different food products."[15]

2.1.2 Specific characteristics of the Agri-Food Supply Chain

AFSCs differ significantly from other supply chains due to the specifics of agricultural production, its dependence on natural conditions, seasonal nature of production, specific product characteristics (eg short shelf life and perishability of products) and related logistics. According to van der Vorst[6], some of the characteristics of AFSC are:

1) the unique nature of products because in most cases they relate to goods with a short life cycle,
2) high product differentiation,
3) seasonality in harvest and production,
4) variability of quality and quantity of used agricultural inputs and yields,
5) special requirements relating to transport, storage conditions, quality and recycling of materials,
6) must comply with national/international legislation, regulations and directives on food safety and public health, as well as environmental issues (eg carbon and water footprints),
7) the need for specialized properties, such as traceability and visibility,
8) the need for high efficiency and productivity of expensive technical equipment, despite the long production time,
9) increased business complexity,
10) existence of significant capacity constraints.

Supply chains of agri-food products are characterized by[16]:

1) business relationships that typically confront profit sharing within the supply chain (so-called profit-rebate relationship);
2) treat farmers as substitutable (and usable) inbound suppliers, who often operate in a limited market or under short-term contracts and therefore take on greater risk;
3) the profit from the sale of finished food products is unevenly distributed along the supply chain because processors and traders usually earn a significantly higher share of earnings compared to producers of raw materials.

The agri-food supply chain has two main objectives[17]:

1) to meet consumer requirements and
2) to become and remain economically viable by means of effective chain management.

In addition, the supply chain of agri-food products can be discussed in two ways:

1) commodity chains aimed at processors through which production from agricultural holdings moves downstream as raw material to processors or to commodity exchanges,
2) value-oriented consumer chains that are the last link in food supply chains. Agri-food products usually reach end consumers through retail or directly, ie through short supply chains. Unlike the supply chain, the consumer-driven chain is more regulated and often barred from entering a particular market in the form of legal or voluntary standards that ensure traceability, quality control and food safety.

Comparing the management of food supply chains and the management of non-food supply chains, there are a number of attributes according to which they differ significantly and which will be discussed in more detail in the following chapters of the book: Relationship and Management; Integration and cooperation in the agri-food supply chain; Supply chain agility; Logistics management; Traceability; Food quality assurance and safety; Packaging; Food marketing and labeling; Food waste management and food loss; Food legislation, etc.

2.1.3 Types of Agri-Food Supply Chains

In general, we distinguish two main types of agri-food supply chains[7]:

1. Figure 1. Supply chain activities. "Agri-food chains for fresh agricultural products" (such as fresh vegetables, fruits, flowers). In general, these chains may include growers, stock exchanges, wholesalers, importers and exporters, retailers and specialty stores, and their suppliers of inputs and services. Basically, through all these phases of grown or manufactured products, the internal characteristics of the product remain intact. The main processes are handling, conditional storage, packaging, transport and trade in these goods.
2. "Agri-food chains for processed food products" (such as meat products, canned food products, dairy products, juices, confectionery products, etc.). In these chains, agricultural products are used as raw materials for the production of consumer products with higher added value. In most cases, different processing procedures (eg canning, drying, freezing, etc.) extend the shelf life of food products. Processed food can also be defined as value-added food. Such food can undergo different levels of processing. Eg the first level is chopping, cleaning and packaging of fresh fruits and vegetables and their placement, for example, under a certain brand. In the second level, food goes through simpler processing procedures, such as converting fruits, vegetables, cereals, etc. into simpler food products such as flour or frozen fruits and vegetables, etc. The third level involves using more complex technological processes of processing agri-food products into ready-to-eat food. These can be various biscuits, cakes, juices, canned food, coffee, pasteurized dairy products, etc.

In addition to the fact that all food is very sensitive to a variety of conditions, additional requirements are met by those companies engaged in the production and distribution of perishable food products. In doing business with this type of product, it is necessary to ensure the shortest possible time of their passage through the supply chain[18]. In this case, it is a "cold chain" or temperature-controlled food supply chain that aims to preserve food throughout the supply chain. Specific phases of the cold chain are refrigeration and freezing systems, storage, transport and retail showcases. Appropriate (low) temperatures need to be ensured through all phases in order to ensure microbiological, physiological, biochemical and physical safety and the expected shelf life of food. These are mainly fresh meat and fish, certain fruits and vegetables, and frozen and/or semi-frozen food products.

The next division of the AFSC would be according to the type and number of actors/stakeholders in the supply chain. While Ványi[19] considers that the supply chain consists of at least two members, Mentzer et al.[20] define the supply chain as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flow of products, services, finance, and / or information from source suppliers to end users". According to this definition, it is assumed that at least three members (manufacturer, customer and supplier) are required for the supply chain. However, there are also supply chains in which there is only one producer and end consumer, ie only two levels of the supply chain. Such supply chains are known as "Short Supply Chain-SSC" and are characteristic of primary agri-food chains[21].

Due to the aforementioned specifics of the AFSC and a number of different actors, the AFSC is much more difficult to define and present and depends on the level of complexity. Mentzer et al.[20], in general, identify three levels of supply chain complexity (SC): "direct supply chain", "extended supply chain" and "ultimate (final) supply chain". However, when we talk about supplying consumers with agri-food products, we must point out the fact that most of these products, especially in developing or underdeveloped countries, are sold to consumers through various forms of short supply chains. Also, given today's trends and consumer demands for healthy, home-grown and locally produced food in developed countries, there are various movements promoting local food and the search for alternative forms of food production, distribution and consumption, reconnecting producers and consumers, strengthening local agricultural systems and agricultural markets and building new links between rural and urban areas[21]. Short food supply chains provide a reliable replacement for conventional supply chains, as food reflects the characteristics of 'local', 'natural', 'healthy' and 'reliable'. Words such as "quality", "sustainable" and "traditional" characterize Alternative Food Networks (AFN), denoting small and specialized production[22]. AFNs have certain basic features which include: social cooperation and partnership between producers and consumers, the ability to reconnect

production and consumption with sustainable models, the ability to foster local markets with a regional identity and re-aggregate value in the trade of quality and differentiated products, for example, organic[21]. In addition, conventional ways of selling food, especially agricultural products, are not the most favorable ways of selling for small farmers. In the conventional food chain, processors (industry), traders and various intermediaries benefit the most, while primary producers/farmers sell their products at very low prices. In particular, the structure of the food sector is bipolar, on the one hand, several large companies dominate the market such as multinational companies (eg Nestlé, Danone, Mars, JBS, etc.), and on the other hand, there is a significant group of SMEs operating mainly in regional markets.

Adapted from Mentzer et al.[20] Figure 2 shows the "direct AFSC" and its stakeholders which is also considered a short AFSC[23]1.

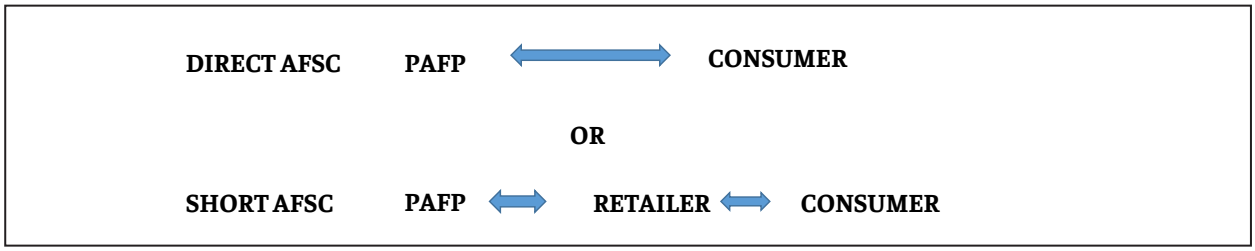

Figure 2. *Direct and short AFSC*
Source: Gajdić et al.[23]

All, and especially longer agri-food supply chains, should be seen as "value chain systems" in which raw materials (from an agro-industrial source) are converted into final consumption as they move through the chain and increase value. Each phase of the agri-food supply chain, conditioned by the specifics of products and processes, significantly affects the logistics of the chain and information and communication technology used in a particular chain or part of the agri-food supply chain.

Adapted from Mentzer et al.[20] Figures 3 and 4 show the "extended AFSC" and the "ultimate or ultimate AFSC" made up of different stakeholders[23].

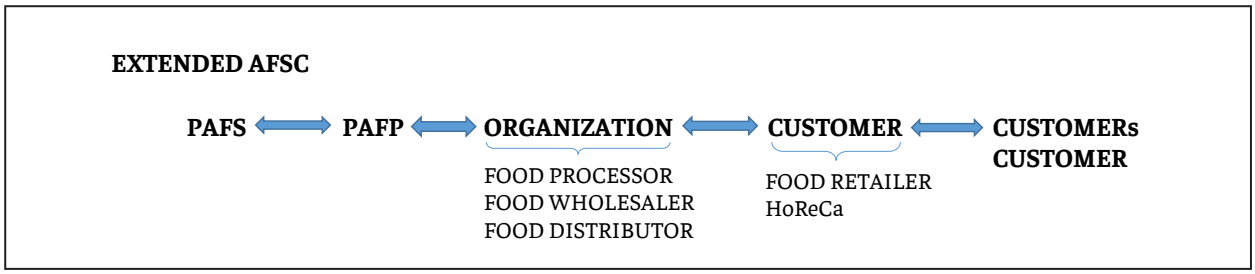

Figure 3. *Extended AFSC*
Source: Gajdić et al.[23]

Figure 3 shows the extended AFSC, but not the entire chain. Depending on the number of stakeholders involved and the type of product, it may look different. The expanded AFSC includes the Primary agri-food supplier (PAFS) as the Primary agri-food producer (PAFP) and other actors involved in the downstream flows of products, services, finance and / or information. A food processor, food wholesaler or food distributor can be found at the site of the organization or central company, and a food retailer or HoReCa, which delivers fresh or processed agri-food products to end consumers, can be found in the role of customer[23].

The ultimate AFSC (Figure 4) covers all organizations involved in all upstream and downstream flows of products, services, finance and information from PAFS to the end user or end consumer. The ultimate AFSC can be very complex, especially if it is an international or global AFSC. Such a chain may include various market helpers, service providers or intermediaries (certification bodies, financial institutions, market research companies, etc.) Given the potential for a myriad of alternative AFSC configurations, it is important

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to note that any of the actors shown may be part of different AFSCs, or part of the upstream and downstream streams that make up the SC[23].

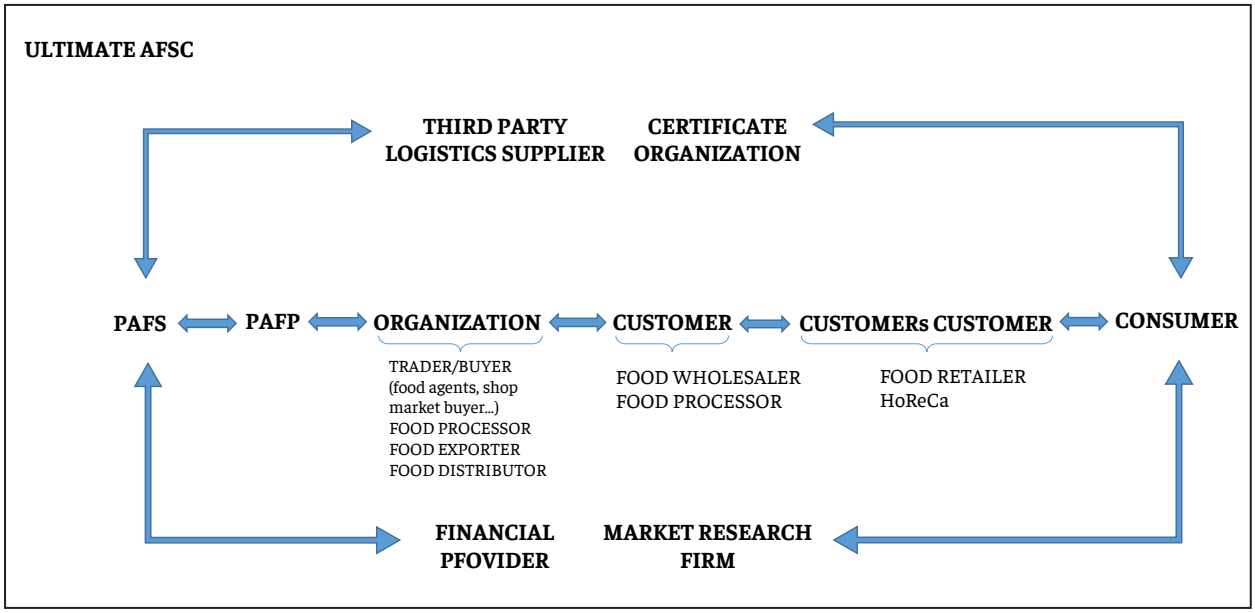

Figure 4. *Ultimate or ultimate AFSC*
Source: Gajdić et al.[23]

The more members in agri-food supply chains, the longer the supply chain and the more difficult it is to coordinate due to specific customer needs, lack of transparency and insufficient information exchange among individual members of the supply chain[24, 25].

Different numbers of partners involved in different business processes along the AFSC while creating a greater variety of complex relationships can significantly affect the performance of the AFSC. One of the critical factors in AFSC is how to ensure quality and fair cooperation among stakeholders while taking care of economic, environmental, social, organizational, marketing and security factors and responsibility towards companies, consumers and society[26]. For this to be achievable, the most effective way to manage the AFSC needs to be found.

2.2 Agri-food supply chain actors and their activities

A typical AFSC consists of several basic phases: source of raw materials/agricultural producers; processing and production of food products; packaging, storage and handling; wholesale distribution; redistribution to retail consumers. The first phase refers to the production of inputs for agricultural production, which includes the breeding of animals, crops, etc. From this phase, the products are distributed to the market or sent to the third phase, which relates to the processing process. In this phase, the transformation of input products into finished products takes place, which are then packaged and stored so that they can be later distributed on the market, which would be the third phase. Distribution on the market represents the fourth phase of the food supply chain, while the last phase involves retail distribution and consumption by end customers. Some of these phases (eg packaging, storage, handling) can occur more than once depending on the complexity and length of the supply chain.

If any of these phases are compromised, various problems will arise and the entire supply chain will be in danger. This is where the big problems and challenges that food supply chain managers have to deal with arise. Eg: lack or inefficiency of food traceability, maintaining food safety and quality at all stages, inadequate communication between stakeholders, increasing supply chain costs, inventory management, sustainability of food chains, etc. Figure 5 shows the general agri-food supply chain and common actors in food supply chain. Those are:

1. Primary suppliers of agri-food products that supply raw materials to agricultural producers, ie inputs, eg, seeds and planting material, fertilizers, etc.
2. Primary producers of agri-food products that produce and deliver food in raw form, eg fruits, vegetables, cereals, meat, fish, etc. They can be small businesses, ie family farms and medium or large such as companies.
3. Processors (eg food industry) who use fresh agricultural products from agricultural producers as raw material to create other food products / food according to consumer requirements. These can be meat and meat products, canned, dried or frozen fruits and vegetables, various flours and other products from cereals, dairy products, etc.
4. Distributors, ie companies that act as a link between producers, processors and markets. They are very important stakeholders, especially when it comes to global food supply chains.
5. Wholesalers and retailers who make food products available to final customers/consumers in an appropriate place in certain quantities and of appropriate quality. They create their range according to the requirements and needs of certain groups of customers/consumers.
6. HoReCa (hotels/restaurants/cafes) are an important link between producers/processors and consumers. They procure food from primary agricultural producers or processors and create a new food product, very often "made to order by consumers", ready for consumption.
7. End consumers who are the last and could say the most important stakeholders in the food supply chain. The economic sustainability of the food supply chain also depends on their consumption. The consumer has an extremely important role in the supply chain as the whole process takes place with the purpose of meeting his needs and requirements, all in order to generate profit throughout the AFSC.

Importers and exporters of agri-food products can also be included in the supply chain if it is an international supply chain.

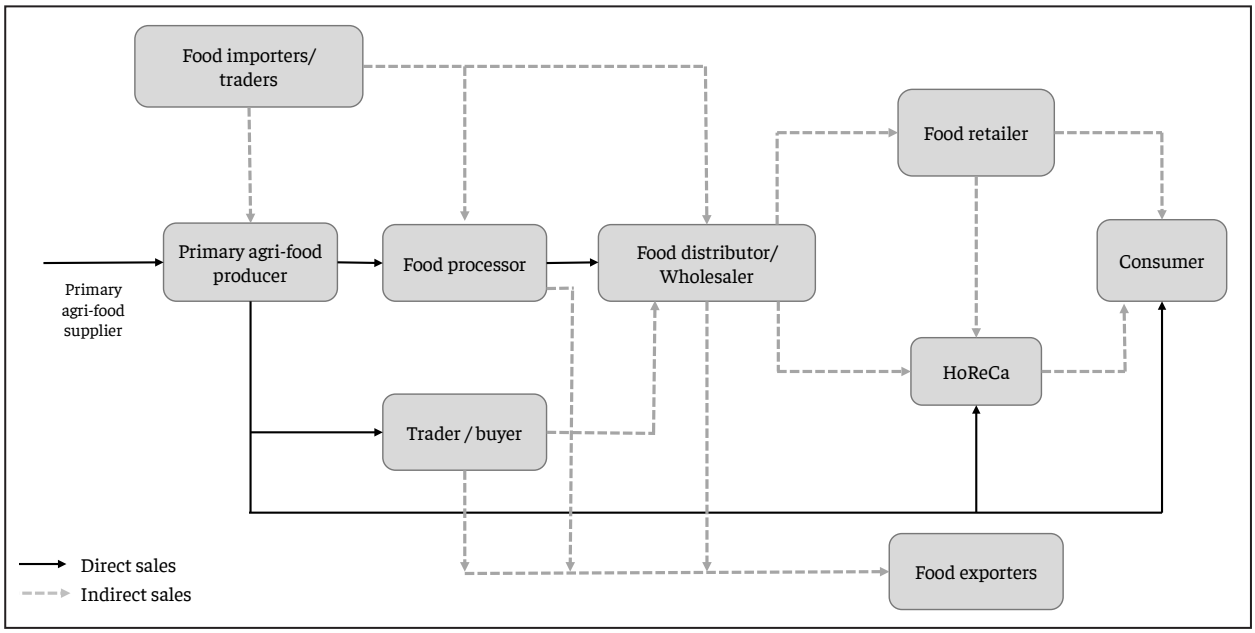

Figure 5. *Actors of the agri-food supply chain*
Source: Gajdić et al.[27]2

Members of the supply chain can be divided into primary members and other members who support the business of primary members of the supply chain[28]. Primary members include all those organizations whose activities participate in the production of a specific product. Other members include companies that help raise resources, contribute their knowledge, or provide assets for primary members of the supply

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chain. These can be transport companies, banks, companies that procure production equipment, companies that deal with advertising, etc. One company can be considered a primary member, but also a supporting member. Such a situation occurs when the company carries out primary activities in one process or supply chain and support activities in another. This means that each company can belong to one or very company and several different AFSCs, ie it usually has more than one supplier and customer. For example, a vegetable producer obtains inputs such as seed and planting material or fertilizer from several different suppliers. It delivers produced vegetables directly to consumers or to one or more processors, who distribute processed vegetables (eg in frozen or canned form) through one or more retail outlets or through HoReCa.

Regardless of the number of members of the agri-food supply chain, it is necessary to ensure an appropriate level of information and product flow at each stage of the supply chain in order to ensure that the quality of food products is maintained.

2.3 Agri-Food Supply Chain Management

The term "Supply Chain Management" is relatively new and it first appeared in the logistics literature of the 80s of the last century as an approach to inventory management with an emphasis on the supply of raw materials. Over the years, the concept of SCM has changed, although it has always been predominantly focused on industrial production and services, and has received surprisingly little attention in agriculture[29]. However, since its introduction into the retail and processing industries, the concept of supply chain management has spread to other industries, including the agri-food sector[7].

According to Chandrasekaran and Raghuram[30], Agri-Food Supply Chain Management – AFSCM involves a range of processes such as supply management, production management and demand management to ultimately satisfy customers through a competitive distribution channel.

Constant and sudden changes in agri-food systems affect the ability of agri-industrial enterprises to compete in the food market. Both small and large businesses face challenges such as reducing operating and other costs, time delays in the flow of goods and information, inevitable innovations, chain sustainability, changes in legislation, and increasingly sensitive consumer demands. With the advancement of local and innovative food products, the product life cycle is shrinking and the role and needs of consumers are constantly increasing. Also, the need to adapt to the constant and rapid changes that are happening in the market and in the entire community is increasing. These changes require managers, owners of small family farms and other stakeholders of any segment of the food supply chain to know and be able to increase their competencies, skills and knowledge, which will inevitably affect the success of the entire supply chain. Large and small companies must continuously work on innovations and improvements, follow trends while adapting to consumer needs. Knowledge and experience in managing food supply chains can help them significantly in this process.

When managing the supply chain, it is very important to achieve cooperation between all members of the supply chain in order to achieve maximum efficiency. If the communication between the organizations in the supply chain is at an enviable level, the preconditions are created for achieving the appropriate level of satisfaction of end consumers, which will ultimately result in an increase in the income of business entities. Supply chain performance will be higher if the profitability of the supply chain is higher as well[31].

2.3.1 Defining Agri-Food Supply Chain Management

Agri-food supply chain management (AFSCM) includes activities or operations from production, distribution and consumption to effective and efficient management of food quality and safety issues[32]. The management of the agri-food supply chain is very complex, and cooperation in the AFSC is largely conditioned by its specific characteristics. Food quality, food safety and freshness over a limited shelf life make AFSCs more complex and difficult to manage, and therefore differ significantly from non-food product chains[32]. The agility of the chain is important for AFSC, in order to be able to respond quickly to changes and challenges in the food sector, such as rapid urbanization, natural disasters, changing nature of food demand,

food quality, food security, traceability, communicable diseases (e.g. COVID 19), accelerated changes in agricultural technology (eg precision agriculture), weaknesses of the rural population in the region in meeting the requirements set by food processing and retail companies, the impacts of climate change on agriculture, etc.[23, 33, 34].

On the one hand, influenced by trends involving globalization, urbanization and agro-industrialization, food supply chains or networks and agribusiness are now moving rapidly towards globally connected systems with a large number of complex relationships. On the other hand, in response to the negative environmental, social and economic effects of the conventional way of selling and based on the logic of quality, which is considered different from the logic of efficiency, short food supply chains are being increasingly developed. They focus on highlighting the quality of food and the ethical, environmental, social and economic conditions of its production[35].

Supply chains can be managed as a single entity through a dominant member or, alternatively, through a partnership system that requires well-developed cooperation and coordination[7]. The goal of each supply chain is to achieve the best possible performance of each individual member of the supply chain and at the level of the entire food supply chain. However, this is not easy because all partners must agree on the selection of key performance indicators and target values.

Lambert and Cooper[36] distinguish three key decisions in SCM:

1. Structure of the supply chain network – who are the key members of the supply chain with which the processes are connected?
2. Supply Chain Business Processes – What processes need to be linked to each of these key supply chain stakeholders?
3. Supply Chain Management Components – What level of integration and management should be applied for each process link?

According to Tsolakis et al.[8] Some of the main strategic, tactical and operational decisions in designing the AFSC would be:

1. Strategic decisions
   - Choice of agricultural technologies
   - Investment portfolio development
   - Encouraging partnerships in the supply chain
   - Supply chain network configuration
   - Establishment of a performance measurement system
   - Ensuring sustainability
   - Adopting quality management policies
2. Tactical and operational decisions
   - Harvest planning
   - Logistics operations planning
   - Support food safety through transparency and traceability

2.3.2 The significant attributes of the Agri-Food Supply Chain Management

As already mentioned, significant efforts are needed to make the right decisions regarding the flow of information, products and resources in supply chain management. Each food supply chain can improve its efficiency and flexibility. In order to improve the performance of the supply chain, effective chain management is needed, ie AFSCM, which focuses on the harmonization of all processes and quality cooperation of all actors in the supply chain.

The AFSCM involves a complex and integrated decision-making process of different AFSC actors. This is particularly pronounced when it comes to the production and distribution of fresh, seasonal and perishable products in the face of high supply and demand instability. In general, AFSC design and planning encompasses all field-to-table processes and stakeholders, starting from the primary farmer and ending with the end consumer. These include issues related to crop planning, harvesting, food processing operations,

marketing channels, logistics activities, vertical integration and horizontal cooperation, risk and environmental management, food safety, ensuring sustainability[8]. The advantages of supply chain management are numerous[17]:

- better control of product quality and safety,
- reduction of product losses,
- better demand management,
- reduction of transaction costs,
- technology sharing and access to capital,
- collaborative knowledge sharing among chain partners.

Stakeholders involved in AFSC face a number of challenges and must systematically make and address a range of decisions important for the successful functioning of all activities at each level of the supply chain, especially in large, complex or international food supply chains.

Some of the most important issues or areas encountered in the planning and management of agri-food supply chains are[7, 8]:

1. Specific characteristics of products and processes

The special characteristics of products and processes in AFSC have implications for actors in these supply chains with regard to the selection of agricultural technologies and processing/production facilities, recording and use of product and process data, communication of data between processes at supply chain level, etc. Fresh food products (eg fruits, vegetables, meat, etc.) whose composition and quality change very quickly over time, will significantly affect the management of processes in the supply chain. For example, the perishability of a product which requires specific storage and transport conditions; differences in the quality of biological products, eg between batches, and even at the level of an individual product (for example sugar, fat content, etc.); or variations in the quality of agricultural products among producers. At the retail level, for example, products closest to the expiration date may need to be sold first, often at reduced prices, etc. Processed food products (for example meat and dairy products, canned or dried fruits and vegetables, etc.) whose process production, composition, produced quantities and quality may depend on the raw material input, ie primary agri-food products (for example origin and history of products; unpredictable yields in primary production, inputs used in production processes, with their effect on processed properties, etc.) they also have implications for supply chain process management.

Within the supply chain of agri-food products there are always several different processes that must be well coordinated and interdependent, ie have an impact on the success and satisfaction of all stakeholders involved in the supply chain and an important effect on the quality of products delivered to final consumers. This means that the final product should have the characteristics that must be achieved when the production processes and the use of resources are in accordance with predetermined specifications. For example, if we buy a product that is labeled organic, it should really be produced and marketed in accordance with the rules for organic food production and distribution. In addition, consecutive continuous production (eg milk) and separate production (eg packaging) often have to be reconciled in the AFSC. Moreover, different actors in the food chain, as well as different consumers and consumer groups have different views on the properties of food products, which poses an additional challenge to harmonize the processes in the chain.

2. Complexity and structure of supply chains

As noted earlier, more than one actor and supply chain process operating in parallel or sequentially over time can be identified in the AFSC. As a result, different companies may have different roles in different supply chain structures and at the same time work with several different supply chain partners, who may be in competition with them in another supply chain. Formal management mechanisms, including vertical coordination and formal contracts, play an important role in structuring / creating food supply chains. On the other hand, particularly short supply chains are often coordinated and guided by informal governance mechanisms that include informal agreements, trust, commitment and reputation. This all has a significant impact on decision-making that will ensure efficient supply chain management regardless of its structure or length and the number of chain members.

3. Information system technology

Since actors in agri-food supply chains are generally part of more than one supply chain, these companies should possess such flexible information systems and communication technology and be able to work with different governance mechanisms for different supply chain partners at different times. At the same time, these systems and technologies should be applied and configured for each supply chain process using a mass adaptation approach and allow for the frequent exchange of vast amounts of information among chain actors. Modern technology and information systems can significantly improve and facilitate the management of supply chains and ensure traceability and transparency throughout the chain (eg Blockchain Technology).

4. Transparency and traceability

A key factor in relation to transparency is production according to pre-defined production standards, specified in quality and safety standards in food supply chains. Timely exchange of information to allow transparency of data, detailed registration of processes, resources and product characteristics, such as product history, quality variations, etc., is crucial for all agri-food supply chains. This is important to enable production management, traceability, recall management and compliance with legislation and other food-related regulations and standards. In addition, divergent and convergent processes and products that significantly affect and sometimes make it difficult to achieve traceability in these chains often alternate in food supply chains. Eg. in the production of dairy products, raw materials (e.g. milk) come from different producers (farms) and are mixed before different finished products (e.g. yogurts, cheeses, dairy spreads, etc.) are obtained for different markets.

5. Satisfying different consumer requirements (mass adaptation)

Consumers have changed in recent decades. They have become more critical and each has its own unique set of specific requirements and desires regarding the production and distribution of food products, imposing a trend of mass adaptation. For the final consumer who uses food for immediate consumption, it is extremely important that the food is safe for human consumption and properly labeled. From the consumer's perspective, we distinguish two basic groups of factors important when making a decision to buy food: external or extrinsic (eg. certificate, known manufacturer, packaging, etc.) and subjective or intrinsic (health, freshness, taste, appearance), where subjective characteristics of quality are more dominant[37]. Quality management of agri-food supply chains achieves improved product and process characteristics, better quality variations throughout the supply chain, product branding, which ultimately significantly affects the decision to purchase food from end consumers.

6. Legislation and government

Each government has adopted formal and informal governance mechanisms that support transparency in food supply chains. Food laws and regulations define various requirements for all entities in the food business. This primarily refers to: meeting the requirements of hygiene (application of good hygiene practice); the obligation to introduce a system of self-control based on the principles of the HACCP system; ensuring traceability at all stages of food production, processing and distribution; meeting the requirements in relation to food labeling or informing consumers in accordance with the prescribed requirements; withdrawal or recall of food from the market if there is reason to believe that the food is unsafe; meeting food quality requirements, etc.

7. Food quality and safety standards

As different actors have a role to play in ensuring the quality and safety of the final product, their activities need to be closely coordinated. Differentiation of food quality begins already in the breeding phase, depends on the conditions of growth of plants or animals in the breeding phase, and the quality is also affected by the method of transport, storage and processing of products. Gathering and sharing different quality information in food supply chains is essential to creating the best possible product quality for the end consumer. Due to the deterioration of quality (perishability) and changes in quality, each individual stakeholder in the

supply chain may impair its competitiveness and performance, and thus affect the competitiveness and performance of the entire food supply chain.

In the food sector, governments focus primarily on protecting public health and safety by creating laws and regulations (e.g., the HACCP system). In addition, nationally and globally, retailers and the food industry have defined a number of voluntary food safety standards in processing and distribution, such as GLOBALGAP, British Retail Consortium (BRC), International Featured Standard - Food (IFS Food), etc. which stakeholders in the food chain must apply if they are to be competitive and part of the global food market.

8. Resolving incidents

All stakeholders in the supply chain must comply with different consumer requirements as well as legal requirements. When incidents occur, companies must, and want to, have the ability to quickly recall products from the market or connect a downstream supply chain to limit the incident and reduce costs. This can be achieved through better management and control of traceability in food supply chains.

9. Accountability and sustainability

Activities and processes of sustainable supply chain management include prevention and reduction of environmental impact, waste reduction, use of environmentally friendly materials wherever possible, recycling and reuse, cooperation with suppliers and other chain partners on sustainability, energy conservation, increasing transparency and traceability in the food supply chain, etc. In the last decade, many companies in the food sector have been encouraged to implement socially responsible business strategies that pay special attention to the ethical aspects of raw material procurement, product production and labor use.

Bibliography

[1] Waters, D (2003) Logistics: An introduction to supply chain management, Palgrave Macmillan, Basingstoke, ISBN 0–333–96369–5

[2] Christopher, M. (2005) Logistics and Supply Chain Management: Creating Value Adding Networks, Issue 3, Prentice Hall, Harlow, ISBN: 978-0-273-73112-2

[3] Bozarth, Cecil B., Handfield Robert B. (2019) Introduction to Operations and Supply Chain Management, 5th Edition, New York, NY : Pearson, Identifiers: LCCN 2017050841| ISBN 9780134740607

[4] Bourlakis, A., Weightman, P. W. H. (2004) Food Supply Chain Management. Blackwell: Oxford/UK, ISBN 1-4051-0168-7

[5] Marsden, T., Banks J., Bristow, G. (2000) Food Supply Chain Approaches: Exploring their Role in Rural Development, Sociologia Ruralis, 40(4), pp. 424–438., https://doi.org/10.1111/1467-9523.00158

[6] Van der Vorst, J. G. A. J. (2000) Effective food supply chains: generating, modelling and evaluating supply chain scenarios, PhD-thesis Wageningen University, available at: https://edepot.wur.nl/121244

[7] Van der Vorst, J. G. A. J., da Silva, Carlos A., Trienekens, Jacques H., (2007) Agro-industrial supply chain management: concepts and applications, Agricultural management, marketing and finance occasional paper, Food and Agriculture Organization of the United Nations, Rome, ISBN 978-92-5-105831-2

[8] Tsolakis, N. K., Keramydas, C. A., Toka, A. K., Aidonis, D. A., Iakovou, E. T. (2014) Agrifood supply chain management: A comprehensive hierarchical decision-making framework and a critical taxonomy, Biosystems Engineering, 120, pp. 47–64. https://doi.org/10.1016/j.biosystemseng.2013.10.014

[9] Dania, W. A. P., Xing, K., Amer, Y. (2018) Collaboration behavioural factors for sustainable agri-food supply chains: A systematic review, Journal of Cleaner Production, 186(June), 851–864., https://doi.org/10.1016/j.jclepro.2018.03.148

[10] Canfora, I. (2016) Is the Short Food Supply Chain an Efficient Solution for Sustainability in Food Market? Agriculture and Agricultural Science Procedia, 8, 402–407., https://doi.org/10.1016/j.aaspro.2016.02.036

[11] Kusumastuti, R. D., van Donk, D. P., Teunter, R. (2016) Crop-related harvesting and processing planning: a review, International Journal of Production Economics, 174(1), 76–92. https://doi.org/10.1016/j.ijpe.2016.01.010

[12] European Commission (2015) You are part of the food chain. Key facts and figures on the food supply chain in the European Union. http://ec.europa.eu/agriculture/markets-andprices/market-briefs/pdf/04_en.pdf

[13] Yared Lemma, D. K., Gatew, G. (2014) Loss in Perishable Food Supply Chain: An Optimization Approach Literature Review, International Journal of Scientific and Engineering Research, 5(5), 302–311.

[14] Shukla, M., Jharkharia, S. (2013) Agri-fresh produce supply chain management: a state-of-the-art literature review, International Journal of Operations and Production Management, 33(2), 114–158. https://doi.org/10.1108/01443571311295608

[15] Bukeviciute, L., Dierx, A., Ilzkovitz, F., Roty, G. (2009) Price transmission along the food supply chain in the European Union, In 112th seminar of the European Association of Agricultural Economists, pp. 3–6. http://dx.doi.org/10.22004/ag.econ.57987

[16] Fischer, C., Hartmann, M. (2010) Introduction and Overview: Analysing Interorganizational Relationships in Agri-food Chains. In Fischer, C., Hartmann, M. (Eds), Agri-food Chain Relationships, CAB International, Oxford, pp. 11–21. ISBN 978-1-84593-642-6

[17] Dani, S. (2015) Food Supply Chain Management and Logistic From farm to fork, London, Philadelphia & New Delhi: Kogan Page, ISBN 978 0 74947364 8

[18] Zhong, R., Xu, X., Wang, L. (2017) Food supply chain management: systems, implementations, and future research. Industrial Management & Dana Systems, 117(9), str. 2085–2114. https://doi.org/10.1108/IMDS-09-2016-0391
[19] Ványi, N. (2013) Members of a supply chain and their relationships. Applied Studies in Agribusiness and Commerce, 6(5), 131–134. https://doi.org/10.19041/APSTRACT/2012/5/21
[20] Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., Zacharia, Z. G. (2001) Defining supply chain management, Journal of Business Logistics, 22(2), 1–25. https://doi.org/10.1002/j.2158-1592.2001.tb00001.x
[21] Gajdić, D. (2019) Definition and characteristics of short agri-food supply chains for products, Ekonomska misao i praksa, 28(1), 381–408.
[22] Maye, D., Kirwan, J. (2010) Alternative food networks, Sociopedia.isa, 1–12. https://doi.org/10.1177/205684601051
[23] Gajdić, D., Mesić, Ž., Petljak, K. (2021) Preliminary Research about Producers' Perceptions of Relationship Quality with Retailers in the Supply Chain of Organic Food Products in Croatia // Sustainability, 24(13), 1–41. https://doi.org/10.3390/su132413673
[24] Ahumada, O., Villalobos, J. R. (2009) Application of planning models in the agri-food supply chain: A review, European Journal of Operational Research, 195(1), 1–20. https://doi.org/10.1016/j.ejor.2008.02.014
[25] Trienekens, J. H., Wognum, P. M., Beulens, A. J. M., van der Vorst, J. G. A. J. (2012) Transparency in complex dynamic food supply chains, Advanced Engineering Informatics, 26(1), 55–65. https://doi.org/10.1016/j.aei.2011.07.007
[26] Fritz, M., Schiefer, G. (2008) Food chain management for sustainable food system development: a European research agenda, Agribusiness, 24(4), 440–452. https://doi.org/10.1002/agr.20172
[27] Gajdić, D., Kotzab, H., Petljak, K. (2023), Collaboration, trust and performance in agri-food supply chains: a bibliometric analysis, British Food Journal, 125(2), 752–778. https://doi.org/10.1108/BFJ-07-2021-0723
[28] Lambert, M. D., Cooper, M. C., Pagh, J. D. (1998) Supply Chain Management Implementation Issues and Research Opportunities. International Journal of Logistics Management, 9(2), 1–20. https://doi.org/10.1108/09574099810805807
[29] Routroy, S. and Behera, A. (2017) Agriculture supply chain: A systematic review of literature and implications for future research, Journal of Agribusiness in Developing and Emerging Economies, 7(3), 275–302. https://doi.org/10.1108/JADEE-06-2016-0039
[30] Chandrasekaran, N., Raghuram, G. (2014) Agribusiness Supply Chain Management, Taylor & Francis Group, Boca Raton, ISBN 9781138627260
[31] Chopra, S., Meindl, P. (2004) Supply chain management: strategy, planning and operations. Second edition. Pearson Education, New Jersey ISBN-10: 0-13-274395-7
[32] Sufiyan M., Haleem A., Khan S., Khan M. I. (2019) Analysing Attributes of Food Supply Chain Management: A Comparative Study, Shanker K., Shankar R., Sindhwani R. (eds) Advances in Industrial and Production Engineering, Springer, pp. 515–523., https://doi.org/10.1007/978-981-13-6412-9_50
[33] Susanty, A., Bakhtiar, A., Jie, F., Muthi, M. (2017) The empirical model of trust, loyalty, and business performance of the dairy milk supply chain, British Food Journal, 119(12), 1–26., https://doi.org/10.1108/BFJ-10-2016-0462
[34] Mathu, K., Phetla, S. (2018) Supply chain collaboration and integration enhance the response of fast-moving consumer goods manufacturers and retailers to customer's requirements", South African Journal of Business Management, 49(1), 1–8. a192., https://doi.org/10.4102/sajbm.v49i1.192
[35] Holloway, L., Kneafsey, M., Venn, L., Cox, R., Dowler, E., Tuomainen, H. (2007) Possible Food Economies: a Methodological Framework for Exploring Food Production–Consumption Relationships, Sociologia Ruralis, 47(1), 1–19., https://doi.org/10.1111/j.1467-9523.2007.00427.x
[36] Lambert, D. M., Cooper, M. C. (2000) Issues in supply chain management. Industrial Marketing Management, 29(1), 65–83., https://doi.org/10.1016/S0019-8501(99)00113-3
[37] Gajdić, D., Petljak, K., Kralj, N. (2019) Percepcije potrošača o sigurnosti hrane u sjeverozapadnoj Hrvatskoj, Proceedings, 54th Croatian & 14th International Symposium on Agriculture | February 17–22, 2019, Vodice, Croatia

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CHAPTER 3

The strategic challenges of food logistics

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3.1 Intorduction – logistics in nutshell

In this subsection we will get acquainted with the specific logistical problems of agri-food supply chains. But for this we first present the general definition of logistics.

Logistics is the process that includes the planning, implementing and controlling of the the flow and inventory between origin and destination of products and services and related information,with the intention of meeting customer expectations.[1]

Logistics is therefore an extremely complex and diverse process system, the obvious aim of which is to ensure that the products and services provided by the company reach customers and direct users in the best possible way (in quantity, quality, place, time, inputs) that best meets the needs of consumers. The content of the „right mode" is mostly determined by the macro and micro environment, consumer expectations and the corporate strategy adapted to them. Above all this, however, are the two general criteria that are prerequisites for the long-term success of all organizational processes, including logistics[2, 3, 4].

Effectiveness expresses the ability of a given process to achieve its goal, to what extent it meets the expectations placed on it. Effectiveness mostly covers areas of appropriate quality, place and time. Effectiveness determines the satisfaction of customers and stakeholders in the process.

Efficiency expresses with how much effort the process can achieve the given result/effect. The efficiency objective function can be formulated in two approaches: a process is effective if it achieves the given result with the least possible input, or the maximum possible result from the given input. These two formulations show that only an effective process can be efficient, but effectivenes alone does not guarantee efficiency.

In the accelerated, difficult to predict and uncertain world of the 21st century, two new criteria that determine the success of logistics systems are increasingly coming to the fore.

By *sustainability*, we mean ensuring the current effectiveness and efficiency of our systems and processes without consuming or destroying our future opportunities and (natural, social, economic) resources.

Agility expresses the totality of an organization's ability to thrive, develop and grow in an unpredictable and rapidly changing environment[].

Logistics systems must therefore meet four general criteria in order to operate successfully: effectiveness, efficiency, sustainability and agility. These criteria are, of course, also valid when extended to the level of

supply chains defined in previous chapters. How these general criteria are filled up with specific content depends heavily on corporate and supply chain strategies. Some possible examples are shown in Figure 1.

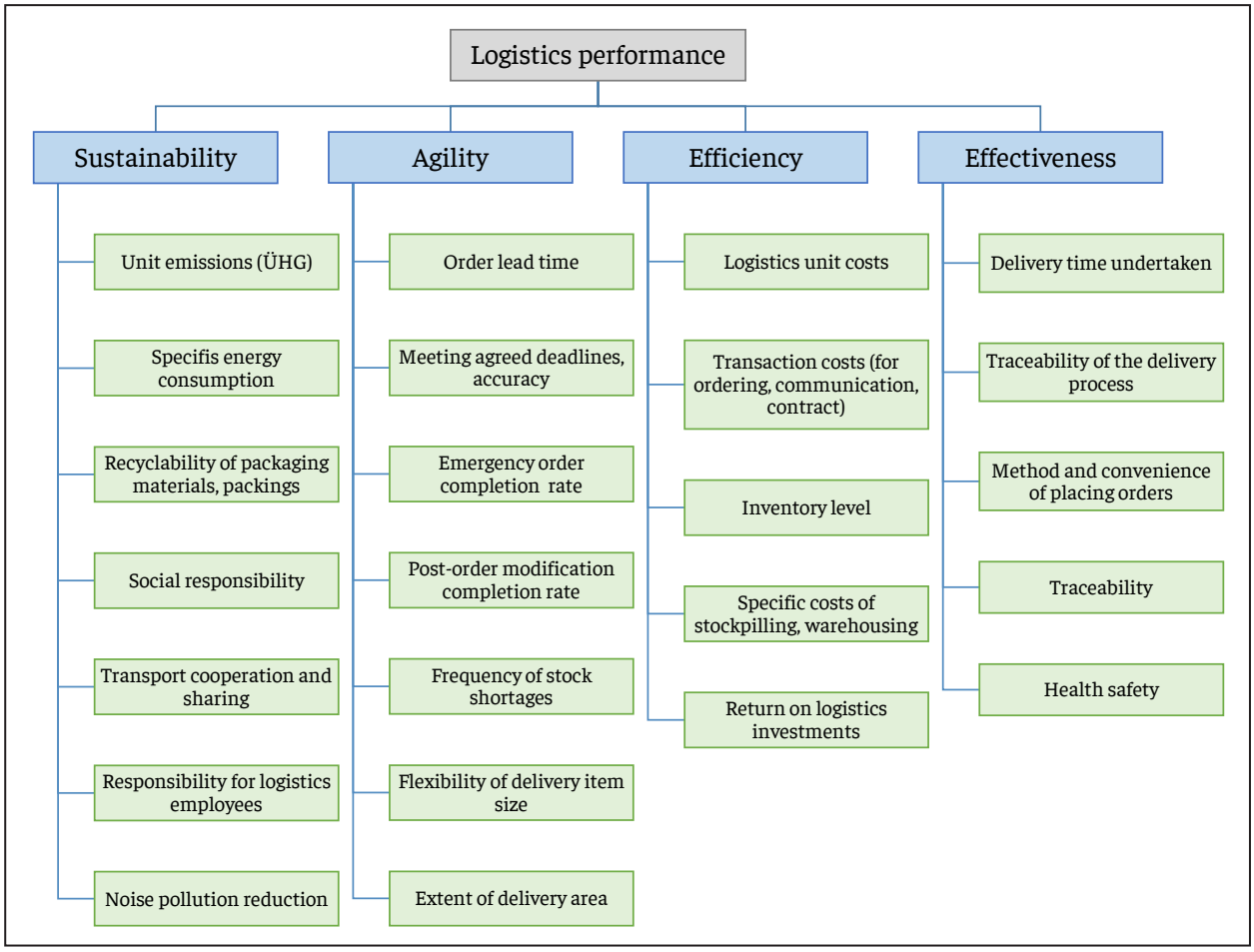

Figure 1. *Examples of logistics performance components*

Of course, logistics performance is realized through the provision of many complex logistics functions and processes. A complete logistics system includes the following components:

- site selection and network planning,
- freight transport and route planning,
- material management and order collection,
- customer service,
- production logistics,
- warehousing management,
- inventory management,
- information systems,
- e-commerce and e-logistics,
- inverse and waste logistics.

Since this volume is not intended for a logistics textbook (many of which are available on the market), we will not go into a detailed description of these functions. At the same time, we consider it important to draw attention to some specific features that relate specifically to agri-food supply chains. In the rest of this chapter, we will focus on these challenges.

3.2 Specific logistical challenges in agri-food supply chains

As in all product lines and sectors, the supply chain approach and the associated logistics toolsystem quickly appeared in the food economy.

The food supply chain is a system of organisations, persons, activities, information and resources involved in the production and transmission of food[9].

In this composite and complex system, the production and delivery of food to consumers is realized through the cooperation of several sectors with completely different structural and economic characteristics (for details, see Figure 2).

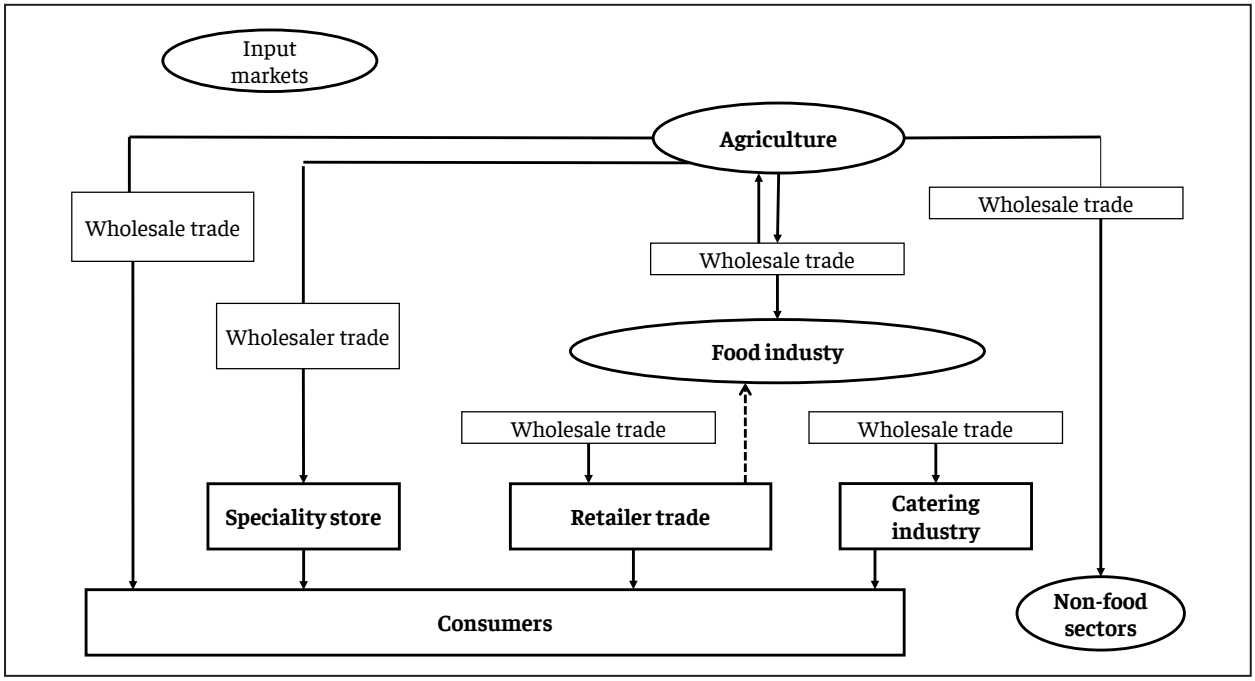

Figure 2. *Schematic model of the food supply chain*
Source: Bukeviciute, et al. [10], *side 5.*

Businesses belonging to the agricultural, food, commercial and other sectors often have to deal with completely different logistical problems and challenges. Overall, therefore, we cannot speak of a single 'food logistics' throughout the supply chain, but rather of specific logistical problems specific to each part of the supply chain, which nevertheless need to be solved in an integrated and cooperative manner by the actors. The main logistical challenges are summarized in Table 1. In addition to the challenges, the table also describes the requirements for the logistics system to successfully respond to them.

Table 1. *The traditional challenges of agri-food supply chains*

Logistical challenges	Logistics requirements
Qualitative and quantitative fluctuations due to living organisms and proximity to nature.	Flexibility of logistics processes, building forecasting and warning systems, incorporating uncertainty into the planning process.
Perishability of fresh food.	Special delivery conditions, ensuring a short order cycle time.
Goods with a high specific weight.	Short transport routes, rail and river freight, where possible.
Variety and diversity of products.	Application of special transport vehicles and storage infrastructure.
Seasonal yields in crop production.	Building a warehouse network, purchasing to a global level.
Social demand for food safety and environmental protection.	Traceability of production and product information.
Product flow complexity.	Logistics planning, ensuring traceability.
Complex network structure, company size, and concentration differences.	Coordination and rationalization of supply and distribution.

Source: Self edit according to Verdouw et al.[11] *and Wajszczuk*[12]

During the 2020s, in addition to traditional challenges, logistics 4.0 requirements modelled on industry 4.0 will become increasingly important in agri-food supply chains. New industrial technologies and their possible applications in food logistics are summarised in Table 2.

Table 2. *The appearance of industry 4.0 in food logistics*

Industry 4.0 components	Possible applications in food logistics
Robotics and automation	Autonomous vehicles and drones for inventory monitoring and management in food warehouses.
Big Data	Optimization of delivery routes, demand forecasting, collection and analysis of customer feedback, inventory management, capacity planning.
Simulation	Delivery scheduling, warehouse planning, planning of transport capacities, planning of lead times.
System integration	Monitoring from farm to fork, demand forecast,
IoT – Internet of Things	Quality management, monitoring, capacity tracking, route planning, hazard detection and prevention.
Cybersecurity	Increasing food safety, risk management
Cloud services	Synchronization of logistics systems, real-time data flow within the chain.
3D printing	Tailor-made food production, reduction of transport and packaging costs.
Augmented reality	Training of logistics specialists, warehouse management systems, support of maintenance operations, quality control, warehouse planning,
Block chain technology	Tracking shipments and products, reducing the administration of international shipments.
Artificial intelligence	Supporting supplier-managed inventory management, supporting cooperative inventory planning and management.

Source: Self edit according to Jagtap et al.[13]

3.3 Customer service level and performance measurement in food logistics

3.3.1 Key performance indicators of customer service level

The level of customer service can be measured by a number of indicators, which should be measured in a complementary manner in parallel. With the help of a system consisting of several indicators, it is possible to get a general overview of the operational effectiveness and efficiency of the company's logistics system. However, it is important to know that these indicators, when viewed alone and statically, do not give information about the "goodness" of the logistics performance of a particular company. Conclusions can be drawn from the value of indicators of the customer service level if values from previous periods are available or if we know the relevant performance of competitors in the same industry with similar characteristics for the period under review. Knowing these, we can already get a relatively accurate picture of the development of the logistics performance of the company under consideration and its position in the logistics competition. In the following, the most important indicators are described based on Gelei[14].

Availability of the product (on time, in full, OTIF)

Shows the percentage of orders shipped in the given period that were successfully completed on time and in accordance with the conditions set out in the order.

$OTIF = \frac{R-HR}{R} \times 100\%$, where

R = the number of orders, order lines, or quantity of products ordered in a given period;

HR = number of incorrectly executed orders, order lines, or quantity of products ordered

Already from the explanation of the formula it can be seen that the OTIF indicator can be interpreted at several levels. We can define it at the level of orders, order/picking lines, or even product quantity. The calculation at different levels is presented through a simple example.

Example 1.
We want to determine the OTIF indicator for 3 orders for a small business engaged in artisanal cheese production. Details of the three orders and their completion are given in Table 3.

Table 3. *Basic data for example 1.*

Order number	Ordered items	Completion
1.	Goat cheese smoked on beech tree 10 pcs Basil soft cheese 20 pcs Gouda cheese 10 pcs	By the deadline, according to the order
2.	Goat cheese smoked on beech tree 20 pcs Peppery soft cheese 20 pcs	After the deadline, according to the order
3.	Lump cheese 10 pcs Mozarella in his own whey 20 pcs Spicy orda 30 pcs Chilli semi-hard cheese in olive oil 20 pcs	By the deadline, mozarella 5 pcs less, Spicy orda 10 pcs less

According to the data in the table, the values of the three levels of the product availability indicator:

- At the level of orders. One of the three orders was delivered after the deadline and one with quantities not matching the order, meaning that two of the three orders were completed incorrectly. OTIF= 33,33%
- At the level of order items. the first order contained three items that the business completed flawlessly. The second order was not completed by the deadline, so both items are considered incorrect. Two of the four items in the third order were delivered in the wrong quantity. In total, 4 out of 9 order items were completed incorrect. OTIF = 55,56%
- At the level of order quantity. The first order was for 20 products, which the business completed correct. In the case of the second order, all 40 products are considered incorrect, as they could not be delivered on time. The third order was for 80 products, compared to which we were able to deliver 15 pcs less. In total, therefore, out of the 140 products, 55 pcs are considered incorrect. OTIF = 60,71%

Average order lead time (RÁI)
This refers to the average time between receiving orders and completing orders. It is calculated by continuously measuring and recording the individual lead time of each order over a given period of time (from the arrival of the order to the delivery and handover of the ordered item). The average order lead time for a given period is defined as a simple arithmetic average of the individual lead times of orders received during the period.

Delivery time reliability (SZHM)
In some cases, customers do not necessarily judge the performance of suppliers based on the speed of delivery, but on the basis of meeting the promised deadlines. Therefore, the percentage of all orders that we can deliver to customers within the promised deadline is an extremely important competitive factor. Keeping the SZHM indicator at the proper level contributes to the establishment of customer confidence, thus increasing the proportion of returning customers. Numerous studies have shown that the marketing costs associated with returning customers are a fraction of the marketing costs associated with acquiring a new customer.

$SZHM = \frac{R-NHSZ}{R} \times 100\%$, where

R is the number of orders received during the period under review,
NHSZ is the number of orders delivered after the deadline.

Damage rate (SA)
During the delivery process, there are several critical points where the transported goods may be damaged. The risk of damage is an integral part of the transport of goods, thus the proportion of products delivered in poor quality.

$SA = \frac{ST\acute{E}}{\ddot{O}K\acute{E}}$, where

STÉ is the value of orders fulfilled without damage,

ÖKÉ is the value of all delivered orders.

3.3.2 Application of performance key indicator systems: basics of the SCOR system

The essence of key indicator systems is that they evaluate logistics performance not with a single indicator, but with a system of indicators consisting of several key indicators. A general feature of these systems is that indicators are classified in a hierarchical order according to specific company/sector needs and into higher-level categories. Thus, at one time, it is possible to derive from the individual indicators performance indicators by category, from which, in turn, we can determine the system performance indicator. Category-by-category and system aggregation is not a general requirement. There are systems in which there are no derived indicators.

The real advantage of performance measurement can be achieved if the indicators are measured not only for one's own, but also for the processes of major competitors. This so-called benchmark activity allows us to be able to identify the position of our own performance in the ranking among competitors.

Of course, for a performance measurement system so sophisticated and composed of many indicators, no general, globally applicable scheme can be given. While frameworks generally exist that can be adapted to all sectors and corporate environments, they must be sufficiently flexible to adapt to the specificities of the company carrying out the implementation. One of the most famous such frameworks developed for supply chains is the SCOR (Supply Chain Operations Reference) system. The SCOR system has been developed by several companies and interbranch organizations since the mid-1990s and is currently maintained and developed by a non-profit organization, the Association for Supply Chain Management. Since its launch, the system has spread very rapidly, being popular mainly among large companies with a global supply network. SCOR itself does not serve as a mere performance evaluation system, but rather as a complex strategic management system, however, it is most often encountered in connection with performance evaluation.

The processes defined in the SCOR framework cover the business processes that occur throughout the supply chain. The standardized elements of the system can be easily adapted to the supply chains of any product path, whether simpler or more complex. The basic model of the system is based on six main management processes[15]:

- *Plan.* Planning processes include defining resources, requirements, and the communication chain in line with business goals. This includes developing best practices for supply chain efficiency while considering compliance, transportation, assets, stocks, and other necessary elements of the SCM.
- *Source.* Source processes ensure the procurement of goods and services in order to meet the planned or actual market demand. This covers the entire procurement and supplier management.
- *Make.* Processes that produce marketable finished products are included, including total production management, material requirements planning, and facility and asset management.
- *Deliver.* Includes order management, freight traffic and distribution processes related to the delivery of finished products.
- *Return.* Backflow processes are related to the management and receipt of products and information that come back from customers or suppliers. This includes also post-delivery customer support processes.
- *Enable.* This includes supply chain regulatory processes such as business rules, capacity management, provision and management of data sources, contracts, compliance with regulations, standards and risk management.

The system offers a total of 250 different metrics to measure supply chain performance, which can be divided into five different performance characterizing categories: reliability, responsiveness, agility costs and asset efficiency. Businesses that use SCOR decide for themselves which performance characterizing categories to prioritize and which to settle for an average performance. Standardized metrics allow system users to compare their own performance with a wide variety of businesses.

Also to help standardization performance is measured at three different levels in the system:

- *Level 1:* the level of configuration of the main processes (plan, source, make, deliver, return, enable), where the scope of the main processes is defined, including geographical scope, industry and customer segments, stakeholders and context (market, industry and macro environment).
- *Level 2:* the configuration of the supply chain by forming process groups within the main processes. Defining geographical scope, line-of-business segments and products can also be important here. Level 2 metrics are multi-process aggregated indicators.
- *Level 3:* here we already identify elementary processes within the subgroups of level 2, and then assign metrics to each process. These level 3 metrics should be clearly attributable to the aggregated process groups and indicators of level 2.

To close the subsection, we present two examples from the international literature of the results of level 1 and level 3 planning.

An international research team conducted a case study of the SCOR model of the global supply chain of air service catering company Emirate Kitchen Flight Catering (EKFC). The three-level planning described above is presented on the basis of the case study. The supply chain level 1 main process map is shown in Figure 3.

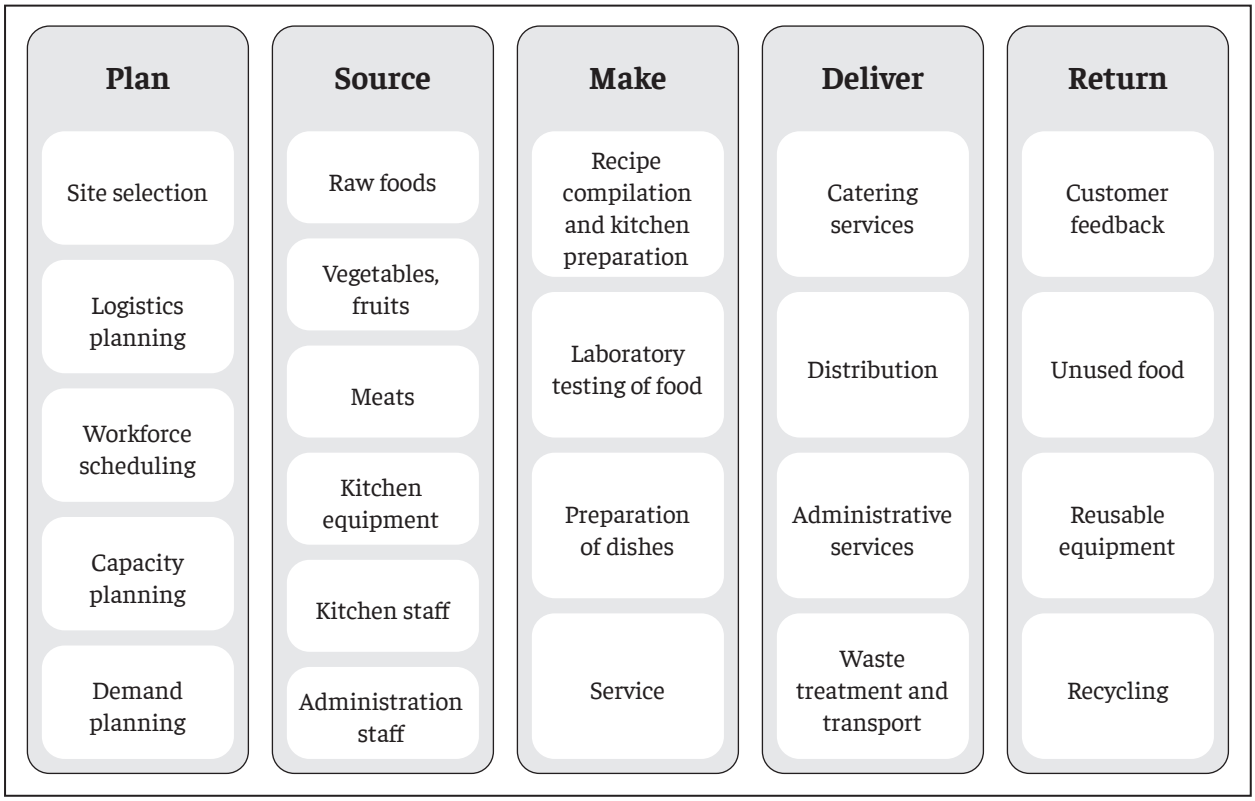

Figure 3. *SCOR Main Process Map (Level 1) at EKFC*
Source: Sundarakani et al.[16], side 489

Figure 3. thus shows the groups of processes within each main process, which can also be called the level 1 main process configuration. During level 2 planning, detailed process maps of process groups and aggregate indicators measured at the level of process groups are then presented. We do not want to present the details of process map making here, more information and examples on EKFC level 2 process map making are available at the link below: https://ro.uow.edu.au/dubaipapers/991/.

An example of a system of level 3 elementary metrics is given from another study. The Indonesian Bureau of Logistics (Bugol), maintained by the Indonesian government, is responsible for organizing and operating the distribution of food critical to national food safety. One of Bugol's activities of such strategic importance is the organization of rice procurement. An insight into the SCOR metrics system for this activity is provided in Figure 4.

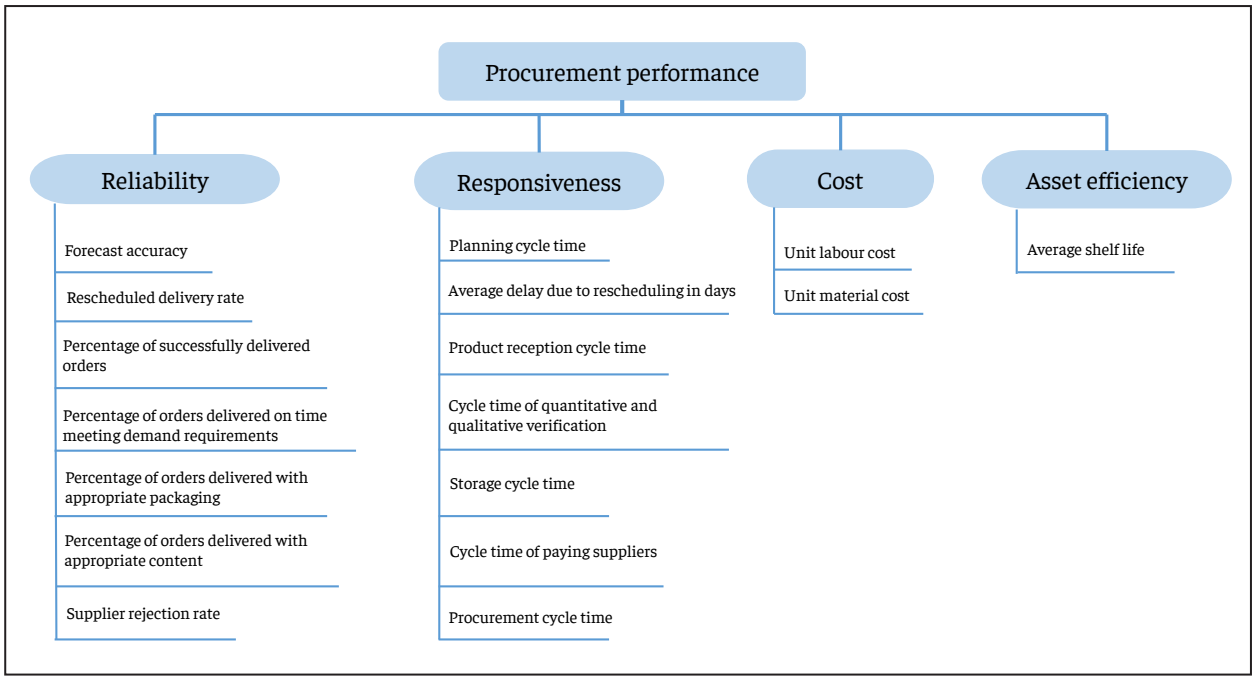

Figure 4. *Key metrics (SCOR Level 3) in the rice purchase of the Indonesian Bureau of Logistics*
Sources: Self edit according to Novar et al.[17]

Details on the explanation of each metric, other elements of the SCOR system are available at the link below: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8708814.

3.4 Procurement management in the food economy

3.4.1 Ensuring the supply of inputs to agricultural production

The starting point for the material needs of the food supply are the inputs necessary for agricultural production. In both crop production and animal husbandry, the current assets that most determine production results can be well defined.

Chemicals and propagating materials are a very significant factor in the production of food of plant origin. The logistics processes of input supply, as in the agri-food supply chain as a whole, are quite complex, since material and information processes take place in these markets between organizations of different sizes and activities with the most diverse economic characteristics. The situation of the supply of propagating material is further complicated by the fact that about 28 percent of the grain seed need is produced by agricultural holdings themselves.

From the above described, it naturally follows that the wholesale sector plays an important role in the supply of inputs, in particular the logistical importance of input-side integrators stands out. Commercial firms that typically reach medium and large company sizes integrate farmers “from two sides”:

- on the one hand, as input distributors, they act as a bridge between chemical manufacturers and seed producers and the large number of agricultural holdings using their products;
- on the other hand, they buy up and market the produce of the partner producers under cultivation contracts.

The activities of integrators go significantly beyond trade. Within the framework of cultivation, a number of additional services (consultancy, input financing, training, information management) are provided to producers. Integrator services now include logistics services. The market-leading integrators have their own nationwide distribution network, which includes their own fleet of vehicles, a regionally divided warehouse system, a system of regional centers and a network of stores that also provide nationwide coverage. With

their help, it is easy to not only minimize order fulfillment times, but also to deliver the sold inputs to the warehouse.

The organisational structure, which is divided by business unit and geographically, allows flexible adaptation to the needs of local users. In parallel, with the help of internal integrated ERP and information systems, distribution processes can be optimized at the company level. Smaller, regionally important input distributors also place great emphasis on logistics services, including freight organization. The economies of scale disadvantage compared to their competitors engaged in nationwide distribution are reduced by strategic alliances, the creation of joint ventures. Through the agrochemical joint venture, the owner companies are also able to implement distribution with nationwide coverage.

The largest share of the turnover of feed mixtures, premixes and feed supplements is carried out by feed manufacturing and distribution companies operating in industrial-large-scale conditions. Most of these manufacturers are present in Hungary as members of trans- and multinational groups. Their distribution activities are characterized by duality: in addition to selling directly to larger production plants, they also carry out retail sales through a network of contractual partners. Their distribution activities are complemented by the professional consulting service. This group also includes importing companies engaged in purely commercial activities.

A possible distribution scheme for feed supply is illustrated in Figure 5. A relatively new way of retail distribution is mobile sales by vans, which can be a suitable solution primarily for backyard and small goods-producing family farms.

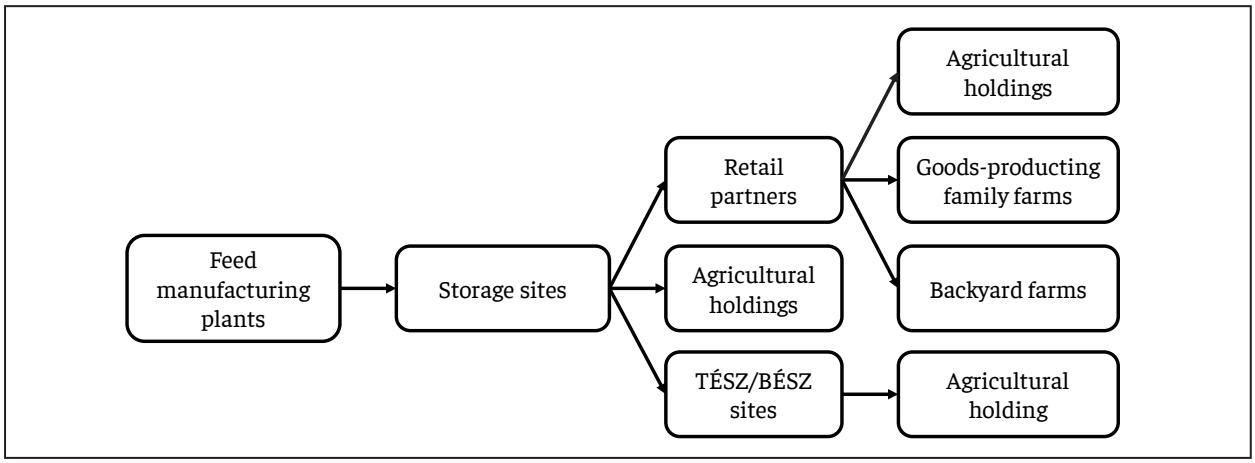

Figure 5. *Distribution scheme of feed manufacturer large companies*
Source: Self edit

The third group of input supply coordination consists of food processing companies. Although these entities are not directly involved in the input market, their involvement in this area may be justified in several respects. The quantity, quality and method of use of the input materials used have a major influence on the following factors of agricultural products

- specific yield, security of production volume;
- quality and quality homogeneity;
- cost of its production;
- nutritional indicators.

3.4.2 Ensuring the supply of raw materials in the food industry (incoming logistics)

A significant part of the products produced in agricultural production is not sold as final products and is bought up and processed indirectly or directly by the food industry. A very significant part of the added value is only then created. Thus, one of the central moments of the domestic food supply chain is the delivery of agricultural products of plant or animal origin and live animals from the production site to the processing site. The main steps of this can be summarised as follows.

Supplier selection

The supply of raw materials can be ensured from several sources. Acquisitions can take place directly from producers, cooperatives, small wholesale companies, integrators. In Domestic practice, these sources of supply are often present simultaneously in the supply base of a single processor. Since our accession to the European Union, there has been a clear rise of integrators and cooperatives. The reasons for this[18, 19]:

- these organizations concentrate a large supply volume, which reduces the complexity of the supply network;
- the provision of services to producers to increase production security and thus supply security (e.g. consultancy);
- a significant number of cooperatives and integrators take on some of the tasks of contact, communication, storage and transport scheduling and organisation;
- through these organisations, both the quality assurance of the production of raw materials and the traceability of the products purchased are better ensured;
- seasonal fluctuations in supply can be eliminated;
- the qualitative homogeneity of the raw materials is also controlled and required by the intermediary organization.

Overall, therefore, cooperatives and integrators simplify the procurement process in many areas. However, choosing the right suppliers is still a rather complex process, which is based on multi-criteria assessment. The most important of them are[20, 21]:

- value for money offered by the supplier;
- supplier size (quantity of sheet), transport distances, the existence of a contract (vertical coordination) and quality certification;
- Choice of transaction management structure. According to the way in which transactions are organized between suppliers and buyers, so-called governance structures can be distinguished. Structures can be classified according to whether free market or hierarchical nature dominates the management of transactions.

The advantages of the free market mechanism are flexible adaptation to price changes, autonomy for organisations and, from the customer's point of view, the possibility of competitive tendering of suppliers. The disadvantage, however, is that the partner's performance and market behavior can be little controlled and sanctioned. Conversely, with perfect integration, coordination is much easier, but adaptation to price changes is less effective. Domestic medium and large companies in the food industry are increasingly deciding to attract suppliers to the ownership interest, or possibly to acquire them altogether. In recent years, there have been several examples of the construction of groups of companies ranging from input supply to food processing. The risks of supply can be significantly reduced by this.

Organization of the supply of raw materials

The coordination of the delivery of the raw material to the place of use can be the responsibility of both the supplier and the customer. In today's practice, the transport of products of plant origin is typically carried out by suppliers, and the transport of products of animal origin and live animals is typically carried out by customers. In many cases, the obligation to bear costs and perform coordination tasks is separated (e.g. the supplier takes care of the transport organization for the time scheduled by the customer, for which he subsequently receives logistical reimbursement). Food companies that take on the costs and coordination of freight transport are also characterized by outsourcing of raw material transport activities. The downsizing of own fleets achieves significant cost savings and improved transport performance indicators.

Quality acceptance of incoming freights and establishment of compensation

For the vast majority of agricultural products purchased, there are numerical and measurable quality indicators that affect the productivity and efficiency of processing. It is in the interest of both the agricultural and food sectors that, based on the results of correct quality acceptance, suppliers who achieve better indica-

tors than the average can receive premization and surcharges commensurate with their performance during compensation. There are product paths (e.g. sugar, milk) where quality-based premization works according to a relatively well-developed system, but unfortunately there are also some (e.g. pig product path) where all the technical conditions are given, yet only a part of the processors have developed a real quality-based benefit system.

3.5 Organisation of short agri-food supply chains

Nowadays, more and more are seeing the light of day in relation to local products and short food chains (RÉL). In Western European countries attention to local products began to gain strength decades ago. Thanks to this, consumer demand for regionally specific, even multi-generation, conventionally produced food products has emerged. The main challenges related to RÉL are presented using the article by Horváth, Szerb and Csonka[22].

3.5.1 The definition of short agri-food supply chains

The concept of a short food chain in the literature is defined by the authors in different ways. According to Renting et al. (2003, p. 394) „... inter-relationship between actors directly involved in the process of production, processing, distribution and consumption of food."[23]

Short food chains were divided into the following types by Jarosz[24] and Ilbery-Maye[25] based on their spatial extent and sales mechanisms:

a) Direct sales
There is a direct relationship between the producer and the consumer at the moment of sale. The condition for re-buying is the right quality of goods and a good experience at the time of purchase. The place of sale can be: roadside point of sale, farmer's living yard, home delivery, farmers' market, web store, pick yourself, guest table.

b) Community marketing-based sales
In the course of social marketing-based sales, the relationships between the RÉL actors are represented in an institutionalized form. There are many studies on producer or consumer cooperative shops created as a result of social marketing, which provide an excellent opportunity for producers to appear on the markets. In addition, various forms of direct delivery to local catering establishments, mass catering establishments or local product stores are also popular. In recent years, thematic festivals and farewells have become increasingly popular, which can also be a point of appearance for producers.

c) Extended supply chain
In the case of the extended supply chain, the producer is not in direct contact with the consumer. One or more intermediaries enter the chain, whose task is to transmit the relevant information in the channel from the producer to the consumer. The most important such information is the exact origin of the food (e.g. food from a family farm, from permaculture, organic, national park or regional food).

3.5.2 Benefits of short food chains

Benefits to producers
According to all international surveys conducted in community-supported agricultural systems, the responses of the farmers surveyed showed a lower than average age and higher education[26, 27]. Similar demographic values can generally be seen by producers in other supply chains. Farms are usually small, the average plant size does not reach 10 hectares[28, 29]. In short supply chains, farmers are characterised by flexibility and openness to innovation[30]. It is a difficult task to transform the plant to such a level that it

becomes suitable for participation in the community-supported agricultural system, as consumers expect the continuous provision of fresh and varied food. In order to achieve this, plants switching to RÉL supply must develop both efficient and flexible operational operation and a form of communication. This is partly the reason why it is mainly young and skilled producers who are engaged in alternative forms. The fact that joining an existing network requires from the farmers a wide range of skills and a tendency to innovate also benefits young and skilled producers.

Trust is an essential condition for the emergence and success of a short supply chain[30]. Traditional and farmers' markets in large cities attract different layers of farmers. In the case of traditional markets, higher prices, instant cash payments and habits are more important, whereas in the case of farmers' markets the influence of the same factors is less motivating. The farmers' market sells farmers who can manage a larger area and have a wider range of products and additional investment plans. Membership in cooperatives and participation in informal collaborations also have an impact on market vending decisions.

Benefits to consumers

A short supply chain meets the needs of two types of consumers[29]. One type basically prefers a conventional food supply and only occasionally takes advantage of the opportunities offered by a short supply chain. The other type is a completely purposeful consumer for health, ethical or other reasons and specifically tries to avoid the usual general solutions.

Serious sacrifice and a change of mindset on the part of consumers are needed if they want to buy only (or mostly) local food. Examples of such sacrifices include the abandonment of fruits that do not grow locally and other foodstuffs, or the periodic avoidance of food that, due to climatic conditions, can only be produced periodically locally. In addition to these, one should not forget about the abandonment of the convenience provided by supermarkets, where everything can be bought in one place, is constantly available to consumers, and in many cases even cheaper.

Benefits to society

Rural development also plays an important role for local economic development for short food chains[31, 32]. Local producers can become suppliers to institutions with a local public function, with the support of central or local government. The more distant goal of these public catering programs is also to improve the health of children from lower-income families. From the point of view of the producer, the great advantage of such programs is that the state order can form a predictable, secure market. On-site processing increases employment and has a multiplier effect, which can further strengthen the local economy. Another advantage of the programs is that school classes can actively participate in factory visits and excursions, and they will be able to use the experience gained there in the school or even in the home garden, thus completing environmental education.

3.5.3 Logistics problems in short supply chains, in particular environmental challenges

The environmental impacts of short food chains are double-edged. It is logical and confirmed by a source of literature that short transport distances related to the local food supply (either in the transport of live animals or in the distribution of finished products) reduce both transport costs and emissions associated with transport processes. An important environmental advantage of local food systems based on geographical proximity is that transport distances are reduced. However, this benefit may be eliminated by the travel overhead for consumers. The realisation of the benefits therefore requires an efficient and high-quality organisation of consumer service (e.g. forming an environmental and user-friendly delivery). Even if special storage conditions are ensured (e.g. refrigerated storage), there is a possibility that the specific energy consumption and the emission of harmful substances of the RÉL exceed that of even imported products. However, other researchers stress that, when measuring energy use at the system level, the energy efficiency of well-established and managed international supply chains may even be better than local food systems with a small transport distance, but operating in a decentralised manner and capable of achieving smaller sales volumes. The balance could be clearly tilted towards local supply if the costs of covering the transport

distance between producer and consumer are more borne by the customer, as the chances of organising multipurpose journeys on the customer's side are significantly better. In this case, of course, the travel costs incurred are not only "charged" for the transport of the purchased product, but are also divided among the other purposes related to the travel. This type of transaction, which takes place at the site or near the site at a point of sale, can take place within the framework of direct sales by producers or community production programmes typically linked to a settlement. However, there is a serious risk of such production systems that processing capacities created for the supply of a single producer or a narrow community operate for a significant part of the year with low utilisation and overall poor efficiency.

Transporting a product from the place of its production to designated markets or food centres is the most complex and cost-effective process, and thorough, accurate and precise planning is required to ensure the smooth operation of this process. Transport costs are a very important aspect for companies, they can transport as many products as possible at as little cost as possible, so transport vehicles must be used to the maximum in terms of their carrying capacity. Thus, even a large amount of products can be profitably transported to closer settlements. Logistics and resources spent on a short supply chain are ignored or underestimated, despite the fact that logistics has been decisively improving the quality of traditional supply chains for years. In long chains, there is not only one type of logistics organization, since it can vary depending on the method of supply and the destination of the product. Warehouses perform more key functions in the supply chain, storing the product for a longer or shorter period of time at the right temperature, or labeling and repackaging it so that it can be further delivered to the target market.

The problems illustrated here are serious, but not unsolvable. The most important question is whether the organisational and infrastructural background and production volumes behind short food chains are ensured, with which an efficient logistics system can be developed. An excellent example of this is the Székely product trademark created by the Hargita County Council in Romania. The trademark system satisfies the conditions of both local food systems and short supply chains. The system also includes food, industrially produced non-food products, handicrafts and intellectual products. Effective outreach to consumers is ensured by a multi-element sales system.

The Council organises a monthly farmers' fair. On it, consumers reach products in a concentrated way in space and time. The cost of traveling to the fair and the emission of harmful substances are not only charged for the purchase of RÉL products, as other tourist and cultural attractions accompanying the fair are also an important part of the supply. Fairs are organized at regular, predictable intervals, so that the purchase can be well scheduled. Regular local fairs are complemented by the organization of participation in domestic and foreign festivals and trade fairs, so that the products are occasionally "released" from the local market, increasing the viability and competitiveness of production. The third element of the sales mix is sales to local stores and chain stores. These commercial companies, while guaranteeing a secure market outlet, have an efficient logistics system that allows fast, cheap and low specific energy transport and storage. Thanks to the use of such conventional sales channels, the trade mark system can provide producers with a stable market and economic development. Although this is a compromise in terms of maintaining the RÉL nature of the trademark system, it also allows for local development of the system. In recent years, significant processing capacities have been established in Székely Land to increase the added value of products, with the help of self-resources provided by the steadily increasing sales turnover and with the involvement of tender resources. Increasing the degree of processing further improves the competitiveness of the products of the trade mark system.

3.6 Stocks in the supply chain

It is a legitimate consequence of material flow processes that the flow is interrupted and stopped from time to time. When tangible materials stand in a given place for a given period of time, "waiting" stocks are formed.

By stocks we mean all material goods, products that are available in the company at a given time[33].

Of course, it is not that the material flow just stops "spontaneously" and the stocks suddenly "form" on their own. Conscious and managed inventory activity is necessary because the individual stages of product

production and the sale of finished products consist of stages that cannot be precisely matched in time and space. Rationally formed stocks thus serve to bridge gaps in space and time.

Stocks are material goods that a company accumulates in order to use them in its subsequent production and sales processes.

Excellent examples of the significance of time differences are provided by the food economy. In the case of plant-based foods, the raw material from agricultural production is typically produced once a year in large quantities, while the market demand for the processed food product is continuous throughout the whole year. The same is true for feed for farm animals. Another example is agrochemicals, which are one of the most important input groups in crop production. They are manufactured continuously for economic and capacity utilisation reasons, but are typically used on a campaign basis.

3.6.1 Classification of stocks

Stocks can be classificated in several ways. In this subsection, the most commonly used classification methods are presented.

The essence of *accounting classification* is that the breakdown is distinguished by the origin and form of appearance of stocks. By origin, stocks are divided into two large groups: purchased and own production stocks. Subgroups by form of appearance are summarized in Figure 6.

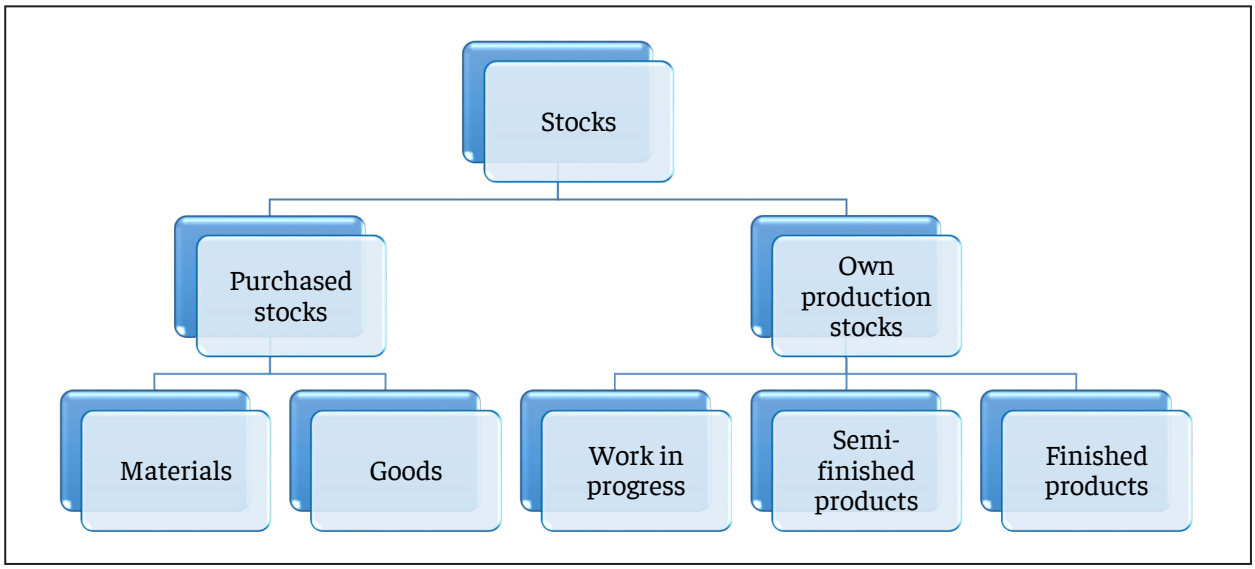

Figure 6. *Accounting classification of stocks*

The essence of another classification option, the so-called *functional classification* is that stocks are classificated not according to form of appearance or origin, but according to their role in economy. This also means that the division into groups is carried out at a completely different level: it makes sense to carry out the functional division within a stock keeping unit.

Stock Keeping Unit, SKU: a stock element which is clearly distinguishable from all other stock elements according to given characteristics and within which there are units of stock which are homogeneous according to those characteristics and which cannot be further broken down[34].

The design of stock keeping units can be carried out on the basis of a number of properties. Some examples for characteristics: manufacturer, material, size, packaging, warranty, product description, etc. For example, in a commercial unit, a stock keeping unit could be an egg of size "M" from farm "X" from deep litter-loose holding.

Within the stock keeping units, we are obviously not able to form additional groups based on the form of appearance. The purpose of the functional division is to determine, for a given SKU, how the stocked quantity or value is distributed across stocking goals.

The most important stocking groups by stocking goals are as follows[35]:

- *Planned stocks* are designed to prepare for forecast and estimated changes in supply and demand. The amount of stock included here is able to meet the demand and needs for SKU in addition to "normal course of business", smooth internal and market processes. It is easy to see that the planned stocks are burdened with significant risk. We can only estimate the demand for each period. There are inaccuracies in our forecasts, and unexpected orders, unpredictable demand run-ups, and other disruptions (e.g., temporary disruptions to stock refill) may occur at any time.
- Preparation for unexpected demand events and supply disruptions is provided by *security, also known as buffer stocks.* They can be perceived as a kind of safety margin, with which we are able to "weather" extraordinary events, to ensure a continuous flow of products.
- In many cases, it happens that for a particular production process, the flow of material occurs in stages, cyclically, from the preventive process. In such a situation, *cycle stocks* ensure production security between two supply periods. In another approach, a volume of stock that is sufficient to meet the demand between the time between the order placed for refill and the receipt of the ordered item can be called a cycle stock.

3.6.2 Stocking cost

The costs incurred in connection with stocking can be divided into three parts, depending on which processes in stocking they arise.

1. Stock keeping costs (often mistakenly referred to as warehousing costs) arise in connection with the storage of stocks in a broad sense and the associated additional processes. The main costs here include[36]:

- Opportunity cost of capital invested in stocks. The capital lying in the form of stocks in the warehouse may not be used for other profitable activities or developments, nor can it be committed to financial investments until it is returned. The resulting loss of profit is not shown as an explicit cost, however, we must nevertheless take it into account between the expenses of stocking.
- Costs incurred in connection with warehousing processes. These include depreciation or rent of warehouse buildings, personnel costs of warehouse employees, warehouse energy consumption, or costs of register and guarding.
- Loss due to a decrease in stock value: damages resulting from physical wear, deterioration, obsolescence, theft, or other deterioration.

Stock keeping cost elements are typically in linear relationship with the stock value: the higher the stock value in warehouses, the higher the stock keeping cost will be. The indicator that expresses the correlation numerically is the stock keeping cost rate. The stock keeping cost rate expresses, for a given period (e.g. a year), the number of units of stock keeping costs per unit stock value over a given period.

2. Ordering costs incure in connection with the refill of consumable stocks. Typically periodic expenses that are independent of the order quantity. The most important costs included here:

- costs of contact with the supplier;
- administrative and communication costs of order preparation;
- transport costs;
- costs of receipt and quality control of incoming shipments.

Part of the stocks (semi-finished and finished products) are not ordered by companies from external partners, but are produced by themselves. In this case, too, a kind of "internal ordering" cost arises. This is nothing more than the cost of switching production capacities (e.g. production lines) to the production of a particular product. In the food industry, for example, it is usually the case that a product has variants with several flavours. At this time, variants with different flavors are produced on one production line, producing one version at a time. During the switch from one flavor to another, downtime and the associated loss of capacity are to be considered as losses.

3. Stock shortage cost arises when we are unable to satisfy a customer order due to lack of available stock. In the case of an unsatisfiable customer order, we need to distinguish two cases according to whether the customer is willing to wait until his order is fulfilled at a later date.

- If the customer does not cancel the order, the company must do everything possible to satisfy the demand as quickly as possible. By this we mean the priority production or purchase of the requested product(s) from an external source, as well as the emergency delivery of the order item. However, there are also administrative costs for maintaining the order.
- The situation is even worse if the buyer cancels the order. In this case, we have to count the loss of collateral for the missed sale as an immediate expense.

The list shows that identifying, measuring and recording stocking costs is not always an easy task. Many of the cost elements described here are implicit (hidden) and the separation of explicit costs is only possible with a well-operated management information system.

3.7 Inverse and waste logistics

3.7.1 Defining inverse logistics

Inverse logistics is located within waste management logistics, it got its name from the fact that the goods (which in this case are waste) have the opposite direction to the direction of flow of the product production. Inverse logistics is the development of a waste supply/processing chain (WSC) within the extended supply chain (ESC). Through this activity, it supports the reduction of environmental pollution, the return of production factors to supply chains, contributes to the development of circular farming, the reduction of the ecological footprint and helps to ensure the concept of sustainable development. Another approach is that inverse logistics is a broader category than waste management logistics and environmental protection is just one aspect of the concept. There is also an approach whereby it means expanding the satisfaction of individual customer needs (traditional logistics processes) with the social need (inverse processes) to collect packaging material, car wrecks, etc. left over from use for utilisation or disposal[37].

Grouping can be carried out according to several criteria based on the literature, a summary of which is presented in Table 4:

Table 4. *Classification of inverse logistics*

By source[38]	**By extent**[39]
Economic inverse logistics	Micro level
Legal-environmental inverse logistics	Macro level

Based on the source, two types of inverse logistics can be distinguished, which are as follows:

- Economic inverse logistics: Collection and reuse of primary packaging waste e.g. deposit system for beverage bottles.
- Legal-environmental inverse logistics: Collection of types of waste that are not used in their original appearance but as a raw material or energy source, e.g. other agricultural waste.

3.7.2 The concept of green logistics and sustainable agri-food supply chain

In the food economy, the problem of labor shortages and distances triggered the pursuit of new technological solutions relatively early on. Due to these needs, remotely controlled, satellite-controlled machines appeared in the fields, but the category of global products also emerged. These consumer demands require bridging the problem of the availability of a range of products without time (seasonal products displayed per season) and geographical limitation.

As one of the world's largest food producers, the European Union is currently able to influence global production, thereby affecting food prices. Behind the improvement in agricultural productivity, the development of monoculture, irrigation, advanced implements or even pesticides can be highlighted. However, these factors of production place a much greater burden on the environment than in the past, e.g. biodiversity is reduced, nitrogen pollution increases, etc. and the overall energy efficiency of production is reduced in order to achieve higher food production yields. The big question for the next period is therefore: How can the current demand for food continue to be met so that the environmental impact of agricultural production can be reduced?

According to data published by the FAO (Food and Agriculture Organisation of the United Nations), a third of all food produced in the world does not reach the consumer[40]. In the European Union, 87.6 million tonnes of food are wasted every year[41]. In addition to saving the cost of an unnecessarily wasted resource, saved food provides an opportunity to moderate the problem presented above. In view of the above, the EU has decided to halve food waste per capita by 2030 and become climate neutral by 2050 (European Green Strategy)[42]. Among the campaigns that are becoming more and more widely known nationally, the "Live to the full" campaign can be said to be outstanding, for example, which draws attention to raising awareness and supports food rescue with posters, recipe books and other actions.

Although the effectiveness of this type of campaign (reaching end consumers) is difficult and may fall short of expectations, it requires much lower costs than changing other components of the food supply chain[43].

According to a study, about 70% of recycling processes are associated with logistics costs, therefore the proper structure and efficiency of the logistics system is very important. Within recycling processes, additional sub-processes can be divided, these can be[44]:

- the process of collecting spent products,
- the disassembly process,
- the selection process,
- the distribution process and the
- waste logistics process.

Environmental protection and logistics are in connection at several points, including[45]:

- Environmental damage associated with logistics activities,
- Coordination of infrastructure and quality of life in urban development,
- Participation in waste management,
- Participation in the operation of the production chain and waste chain.

Logistics activity itself causes environmental damage, such as the burdens associated with transport, factors related to the collection of goods, factors occurring during storage and distribution. To eliminate them, we can see examples from short-term solutions to long-term planning, e.g. rationalizing the distribution system or introducing new solutions. Logistics also plays an important role in settlement development, since in addition to economic aspects, the living conditions of the people living there are equally important. Logistics can complete processes also when performing the specific tasks of waste management, while its role in the operation of supply chains is also indispensable.

According to a Hungarian study[46] assessing the practical implementation of inverse/green logistics, a large number of companies are already using some less environmentally harmful method, e.g. reuse. However, no possible environmental solutions are used in transport, e.g. use of a route optimization program, use of hybrid vehicles with eco-engines, etc. This was due to the significant cost difference, even though a significant number of the organisations involved in the study declared themselves committed to sustainable development.

As an example, the inverse logistics processes of wine packaging materials are presented by 4R research (Reduction at the source, Replacement, Reusing, Resycling)[47].

Table 5. *The inverse logistics processes of wine packaging materials by 4R research*

Name	Description	Example
Preventive task		
Reduction at the source	Reduction of proportions/quantity of conventional raw material	Label reduction
Replacement	Replacing traditional raw material with an environmentally friendly alternative	Cartons made of environmentally friendly corrugated paper
Reusing	Reuse of materials	Reuse of compartments
Follow-up task		
Resycling	Processing and recycling of materials	Use of wine barrels for other tasks

Despite the fact that agricultural/industrial waste is regulated by a large number of legislation, the producer still has a fundamental influence on the amount and management of waste. Performing preventive tasks is always more efficient than follow-up task. The first of these is when the proportion of traditional raw materials can be reduced or waste can be prevented by reducing the amount of raw material In wine-sector processes, the need for raw materials for bottling wine can be reduced if smaller labels or bottles with fewer raw materials are used. Solutions where compartments are replaced by cartons made of environmentally friendly corrugated paper can also be effective, but it is already an improvement if the compartments are not disposable, but are constantly reused to perform the original function. In the event that the product has lost its original function, but still has usable material, it may be worth choosing its processing instead of producing a completely new product.

There are also good examples of long-term planning. In many cases, it is already taken into account in packaging design that material handling is the biggest cost carrier of logistics, so many goods are sold immediately from pallets, for example at large retail chains such as Tesco or Lidl. With this conscious design, for example the manufacturer can save a lot of packaging materials, as well as make delivery faster and reduce warehousing work.

In Italy, support was given at the legislative level for ‚0 km products' aimed at creating short supply chains[48]. The concept was based on producers being able to sell goods to consumers through direct sales, which motivated a reduction in logistics costs and a boom in local products. Setting a good example, the use of „0 km products" was an advantage in the selection process for food procurement tenders in the region, but in public institutions and mass catering, part of the annual use had to include products of this type.

There is also a case where food waste is handled with an IT solution[49]. At the Sofitel Hotel, the discarded food items are not only sorted, but the amount and cost of them are recorded with a specially designed software called Winnow. With the chosen method, real-time data are available to guide which areas require intervention and targeted actions.

The Szatyor Bevásárló Közösség embodies a grassroots initiative. The implementation of the principles of localization and sustainability is ensured by the basic concept, on the basis of which there is no stock of goods accumulating „stock", the collection points ensure only the service of the pre-placed demand-based order. A maximum distance of 70 km between the place of production of the food and the end-user is allowed, thus short transport distances contribute to reducing costs when purchasing local quality products.

The above examples, whether from below or from above, highlight good practices that suggest a positive vision for the future. The will to adapt technological solutions is proven, all that remains is to strive for availability and affordability.

Bibliography

[1] Christopher, M. (2011) Logistics and Supply Chain Management. 4th Edition, Prentice Hall, London.
[2] Leiblen, M. (2003) The choice of organizational governance form and performance: Predictions from transaction-cost, resource-based and real-options theories. Journal of Management, 29(6), 937–961. https://doi.org/10.1016/S0149-2063_03_00085-0
[3] Jeong, K. Y., Phillips, D. T. (2001) Operational efficiency and effectiveness measurement. International Journal of Operations & Production Management, 21(11), 1404–1416. https://doi.org/10.1108/eum0000000006223

[4] Mouzas, S. (2006) Efficiency versus effectiveness in business networks. Journal of business research, 59(10–11), 1124–1132. https://doi.org/10.1016/j.jbusres.2006.09.018
[5] Walter, A. T. (2021) Organizational agility: ill-defined and somewhat confusing? A systematic literature review and conceptualization. Management Review Quarterly, 71, 343–391. https://doi.org/10.1007/s11301-020-00186-6
[6] Ilbery, B., Maye, D. (2005) Food supply chains and sustainability: evidence from specialist food producer sin the Scottish/English borders. Land Use Policy, 22(4), 331–344. https://doi.org/10.1016/j.landusepol.2004.06.002
[7] Aramyan, L. H., Lansink, A. G. O., Van Der Vorst, J. G., Van Kooten, O. (2007) Performance measurement in agri-food supply chains: a case study. Supply Chain Management, 12(4), 304–315., https://doi.org/10.1108/13598540710759826
[8] Winkelhaus, S., Grosse, E. H. (2020) Logistics 4.0: a systematic review towards a new logistics system. International Journal of Production Research, 58(1), 18–43. https://doi.org/10.1080/00207543.2019.1612964
[9] GMA (2008) Food Supply Chain Handbook. Washington: Grocery Manufacturers Association. https://downloads.regulations.gov/FDA-2011-N-0143-0023/attachment_10.pdf
[10] Bukeviciute, L., Dierx, A., Ilzkovitz, F. (2009) The functioning of the food supply chain and its effect on food prices in the European Union. European Commission, Brussels. https://ec.europa.eu/economy_finance/publications/pages/publication15234_en.pdf
[11] Verdouw, C. N., Sundmaeker, H., Meyer, F., Wolfert, J., Verhoosel, J. (2013) Smart agri-food logistics: requirements for the future internet. In Dynamics in logistics (pp. 247–257). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-35966-8_20
[12] Wajszczuk, K. (2016) The role and importance of logistics in agri-food supply chains: An overview of empirical findings. Logistics and Tansport, 30(2), 47–56.
[13] Jagtap, S., Bader, F., Garcia-Garcia, G., Trollman, H., Fadiji, T., Salonitis, K. (2020) Food logistics 4.0: Opportunities and challenges. Logistics, 5(1), 2. https://doi.org/10.3390/logistics5010002
[14] Gelei A. (szerk.) (2016). Logisztikai döntések. Akadémia Kiadó. https://doi.org/10.1556/9789630598088
[15] Moazzam, M., Akhtar, P., Garnevska, E., Marr, N. E. (2018) Measuring agri-food supply chain performance and risk through a new analytical framework: a case study of New Zealand dairy. Production Planning & Control, 29(15), 1258–1274. https://doi.org/10.1080/09537287.2018.1522847
[16] Sundarakani, B., Abdul Razzak, H., Manikandan, S. (2018) Creating a competitive advantage in the global flight catering supply chain: a case study using SCOR model. International Journal of Logistics Research and Applications, 21(5), 481–501. https://doi.org/10.1080/13675567.2018.1448767
[17] Novar, M. F., Ridwan, A. Y., Santosa, B. (2018) SCOR and ahp based monitoring dashboard to measure rice sourcing performance at Indonesian bureau of logistics. In 2018 12th International Conference on Telecommunication Systems, Services, and Applications (TSSA) (pp. 1–6). IEEE. https://doi.org/10.1109/TSSA.2018.8708814
[18] Esse, B (2008) A beszállító-kiválasztási döntés szempontjai. 90. sz. műhelytanulmány. Budapest: Budapesti Corvinus Egyetem. http://edok.lib.uni-corvinus.hu/278/1/Esse90.pdf
[19] Stringer, R., Sang, N., Croppenstedt, A. (2009) Producers, Processors, and Procurement Decisions: The Case of Vegetable Supply Chains in China. World Development, 37(11), 1773–1780. https://doi.org/10.1016/j.worlddev.2008.08.027
[20] Carr, A., Smeltzer, L. (1997) An empirically based operational definition of strategic purchasing. European Journal of Purchasing & Supply Management, 3(4), 199–207. https://doi.org/10.1016/S0969-7012(97)00014-2
[21] Johnson, P., Leenders, M. (2006) A longitudinal study of supply organizational change. Journal of Purchasing and Supply Management, 12, 332–342. https://doi.org/10.1016/j.pursup.2007.01.007
[22] Horváth, T., Szerb. A. B., Csonka, A. (2019) Logisztikai kihívások a rövid élelmiszer láncokban. In: Bodnár, Károly (szerk.) 5. Logisztika a Dél-Alföldön : Lektorált tudományos konferenciakiadvány. Agro-Assistance Kft., Csongrád.
[23] Renting, H. J., Marsden, T. K., Banks, J. (2003) Understanding alternative food networks: exploring the role of short food supply chains in rural development. Enviroment and planning, 35(3), 393–412. https://doi.org/10.1068/a3510
[24] Jarosz, L. (2008) The city in the country: Growing alternative food netweorks in Metropolitan areas. Journal of Rural Studies, 24(3), 231–244. https://doi.org/10.1016/j.jrurstud.2007.10.002
[25] Ilbery, B., Maye, D. (2005) Food supply chains and sustainability: evidence from specialist food producer sin the Scottish/English borders. Land Use Policy, 22(4), 331–344.Cleveland, D. A., Müller, N. M., Tranovich, A. C., Mazaroli, D. N., Hinson, K. (2014) Local food hubs for alternative food systems: A case study from Santa Barbara County, California. Journal of rural studies, 35, 26–36. https://doi.org/10.1016/j.jrurstud.2014.03.008
[26] Matson, J., Sullins, M., Cook, C. (2013) The role of food hubs in local food marketing (No. 2162-2018-8026). https://www.rd.usda.gov/files/sr73.pdf
[27] Marsden, T., Banks, J., Bristow, G. (2000) Food supply chain approaches: exploring their role in rural development. Sociologia ruralis, 40(4), 424–438. https://eurekamag.com/research/003/449/003449798.php
[28] Mundler, P., Rumpus, L. (2012) The energy efficiency of local food systems: A comparison between different modes of distribution. Food Policy, 37, 609–615. https://doi.org/10.1016/j.foodpol.2012.07.006
[29] Soysal, M., Bloemhof-Ruwaard, J., J. G. A. J., v. d. V. (2014) Modelling food logistics networks with emission considerations: The case of an international beef supply chain. Int. J. Production Economics, (152), 57–70. https://doi.org/10.1016/j.ijpe.2013.12.012
[30] Benedek, Z., Fertő, I. (2015) Miért választják a termelők a rövid ellátási láncokat? Statisztikai Szemle, 93(6), 580–597. https://core.ac.uk/download/pdf/42943666.pdf
[31] Benedek, Z., Balázs, B. (2014) A rövid ellátási láncok szocioökonómiai hatásai. Külgazdaság, 58(5–6), 100–120. http://real.mtak.hu/13891/1/Benedek_BalazsKulg.pdf
[32] Karmaker, C. L., Ahmed, T., Ahmed, S., Ali, S. M., Moktadir, M. A., Kabir, G. (2021) Improving supply chain sustainability in the context of COVID-19 pandemic in an emerging economy: Exploring drivers using an integrated model. Sustainable production and consumption, 26, 411–427. https://doi.org/10.1016/j.spc.2020.09.019
[33] Lourenço, H. R. (2005) Logistics Management. In Metaheuristic Optimization via Memory and Evolution (pp. 329–356). Springer, Boston, MA. https://doi.org/10.1007/0-387-23667-8_15
[34] Trent, R. (2004) The use of organizational design features in purchasing and supply management. The Journal of Supply Chain Management, 40(3), 4–18. https://doi.org/10.1111/j.1745-493X.2004.tb00170.x

[35] Verdouw, C., Verdouw, C. N., Sundmaeker, H., Meyer, F., Wolfert, J., Verhoosel, J. (2012) Smart Agri-Food Logistics: Requirements for the Future Internet. In: Kreowski, H. J., Scholz-Reiter, B., Thoben, K. D. (eds) Dynamics in Logistics. Lecture Notes in Logistics. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-35966-8_20
[36] Van der Zee, D. J., Van der Vorst, J. (2005) A Modeling Framework for Supply Chain Simulation: Opportunities for Improved Decision Making. Decision Sciences, 36(1), 65–96. https://doi.org/10.1111/j.1540-5915.2005.00066.x
[37] Prajapati, H., Kant, R., Shankar, R. (2019) Bequeath life to death: State-of-art review on reverse logistics. Journal of cleaner production, 211, 503–520. https://doi.org/10.1016/j.jclepro.2018.11.187
[38] Mosonyiné Ádám, G. (2008) Inverz logisztikai láncok működése és optimalizálási szintjei. EU Working Papers, (1), 117–130. http://publikaciotar.uni-bge.hu/396/1/2008_1_11.pdf
[39] Réti, T. (2011) Az inverz logisztika tartlma a haderőben. Katonai Logisztika 19(1), 36–45. http://publikaciotar.uni-bge.hu/396/1/2008_1_11.pdf
[40] Food and Agriculture Organization of the United Nations (2019) The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. https://www.fao.org/3/ca6030en/ca6030en.pdf
[41] Caldeira, C., De Laurentiis, V., Ghose, A., Corrado, S., Sala, S. (2021) Grown and thrown: Exploring approaches to estimate food waste in EU countries. Resources, Conservation and Recycling, 168, 105426. https://doi.org/10.1016/j.resconrec.2021.105426
[42] European Commission. (2019) The European Green Deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[43] Read, Q. D., Muth, M. K. (2021) Cost-effectiveness of four food waste interventions: Is food waste reduction a "win–win?". Resources, Conservation and Recycling, 168, 105448. https://doi.org/10.1016/j.resconrec.2021.105448
[44] Blanquart, C., Gonçalves, A., Vandenbossche, L., Kebir, L., Petit, C., Traversac, J. B. (2010) The logistic leverages of short food supply chains performance in terms of sustainability. In 12th World Conference on Transport Research (p. 10.).
[45] Benedek, Zs. (2014) A rövid ellátási láncok környezeti hatásai. Magyar Tudomány, 175(8), 993–999. http://www.matud.iif.hu/2014/08/19.htm
[46] Gyenge, B., Mészáros, K. (2021) Magyarországi vállalatok és intézmények ellátásilánc-és logisztikai gyakrolata–különös tekintettel a fuvarozási és szállítmányozási igényekre és teljesítményekre. http://kea.ke.hu/43/
[47] Ferrara, C., Zigarelli, V., De Feo, G. (2020) Attitudes of a sample of consumers towards more sustainable wine packaging alternatives. Journal of Cleaner Production, 271, 122581. https://doi.org/10.1016/j.jclepro.2020.122581
[48] Kapała, A. (2020) Legal instruments to support local food systems in Italian law. EU agrarian Law, 9(1), 5–11. https://doi.org/10.2478/eual-2020-0002
[49] Okumus, B., Taheri, B., Giritlioglu, I., Gannon, M. J. (2020). Tackling food waste in all-inclusive resort hotels. International Journal of Hospitality Management, 88, 102543. https://doi.org/10.1016/j.ijhm.2020.102543

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CHAPTER 4

Attributes of food quality and sources of danger in agri-food chains

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4.1 Introduction

Food quality is not easy to define. Moreover, there is no single definition of food quality that is comprehensive[1], ie that would contain all the elements of the definition of food quality. W. Edwards Deming defines quality as: "... a predictable degree of consistency and reliability of a product with a quality standard that meets the customer"[2], so it makes perfect sense that the definition of food quality changes depends on changing needs and requirements of customers or consumers.

Food quality is primarily directly related to the sensory properties of a particular food product[3] and each consumer determines the quality of food based on their senses and evaluates: appearance, texture and taste[4]. A holistic approach in defining food quality involves several value groups. These are: the *psychological* or nominal value of food, based on concepts usually difficult to explain, opinions (prejudices) and consumer expectations about the product.

The psychological or nominal value group is followed by a *cultural* or social food value group. This is followed by a *political* group of values that is particularly pronounced in developing countries, and finally there is the *ecological* group of values, which includes an assessment of the environmental impact of food production and processing[5]. However, food quality is also defined by specific types of food such as *ethnic food*[6], which is specific to a particular ethnic group determined by culture, origin, socio-demographic characteristics and even social status[6], such as *kosher*[1] food which must be prepared according to the provisions of the Jewish Food Law, ie *halal*[2] food according to Islamic Law[7].

A specific group of foods includes *functional foods* which, in addition to their nutritional value, also have preventive and / or health benefits [8, 9]. If we add to this a specific form of tourist offer, known as *gastro tourism* (English food tourism [10], and especially *organic food*[11], then it is quite clear that there is no single definition of food quality, but we can speak about food quality attributes or properties in the production chain[12].

[1] *Kosher* in Yiddish is a term for the Hebrew term *kāshér* (כָּשֵׁר), meaning 'fit' or healthy, in good 'shape'.
[2] *Halal* or Arabic halaal (حلال) means pure or permissible.

4.2 Attributes or properties of food quality in the production chain

Attributes or properties of food quality in the production chain[13] are divided into two groups:

1. External or extrinsic quality attributes
2. Internal or intrinsic quality attributes

External or extrinsic properties of food quality[13] relate to:

- Features of production systems
- Environmental aspects
- Marketing and communication.

The characteristics of production systems refer to the entire production process in which a particular food product originated in the entire agri-food chain. This really includes product features such as:

- origin of agricultural raw materials according to location and type of production (organic or conventional)[14],
- use of pesticides, GMOs[15] and treatment of domestic animals[16, 17],
- yields and quality of agricultural raw materials in a given production / vegetation year,
- stability and losses of agricultural products during harvest, storage and transport,
- length of transport[18] and distribution to consumers,
- technological process of processing an agricultural product into a food product, which includes the use of additives, control and analysis during the production process and keeping food products from spoilage[19, 20, 21, 22, 23].

In other words, the characteristics of production systems include all the characteristics of agri-food chains and traceability within the agri-food chain[3].

Environmental aspects of external (extrinsic) properties of food quality are mainly focused on *the impact of packaging materials on agricultural products on the environment*[24, 25] and on *food waste*[26]. Namely, packaging materials and food packaging design must ensure the stability of the food product in the prescribed storage conditions within a certain shelf life, which means effective prevention of spoilage. On the other hand, the most effective packaging materials also pose an environmental threat due to their slow degradability[27]. Due to the growing environmental awareness, most consumers in highly developed countries increasingly consider food packaging waste as a serious threat and choose food products whose packaging is biodegradable[28]. Moreover, such materials are being developed that will completely replace plastic[29]. Some of these materials are already in use and are part of the circular economy[30].

However, when it comes to food losses, as a form of external quality properties of food products, the situation is a bit more complicated. First, food waste and food waste management in agri-food chains[4] have only been discussed for twenty years. Namely, in agricultural production, great attention was paid to losses during the harvest, storage and transport of agricultural products. On the other hand, losses incurred in the food industry, households and restaurants went 'under the radar'. Today, food companies, due to their social influence and economic interests, are making more or less efforts to reduce losses in technological processes[31]. Fifteen years ago, it was noticed that large generators of food waste are members of the last 'link' in agri-food chains, which are consumers divided into two groups; restaurants[32] and households[33]. Unfortunately, this leads to a paradox, because often lower-income households with lower purchasing power waste more food than higher- and middle-income households[34]. In any case, the amount of food waste and food losses must be reduced, and in order to achieve this, many activities are needed to address the cause of this extremely negative phenomenon[35]. However, food waste will always occur in the agri-food chain. Therefore, in highly developed countries, food waste from households and restaurants are seen as a useful raw material in the circular economy[36].

[3] *cf.* ch. 1. Agricultural food chains→ 1.6. Traceability in the agri-food chain

[4] *cf.* ch. 1. Agricultural food chains → 1.2. What are agri-food chains and who are the stakeholders in them?

Marketing and communication as external (extrinsic) property of food quality is something that is given the utmost attention, primarily for economic reasons, ie increased sales and consequently higher profits by food companies. Today, there is almost no serious food company that does not shower consumers with leaflets, promotional materials, advertisements in public media, posters, etc., presenting soy products and emphasizing their nutritional value, quality control of their products to care for consumer health, the origin or originality of raw materials, and often emphasizing the modern technological process of production and implementation of certain quality management systems as a guarantee of safety, reliability and health safety of their food products. Moreover, it is already common practice to find an info phone number on the packaging in a visible place where consumers can express their remarks, complaints and compliments on behalf of a particular food product.

However, in addition to all these activities, food incidents occur, which are most often manifested as acute food poisoning or are prevented in the event that state control bodies, specifically sanitary and market inspection according to the findings of accredited laboratories of state food agencies, act in accordance with their legal authority and order the withdrawal of certain food products from the market. In this case, *risk communication* is applied[37]. By definition, communication in risk situations is the exchange of information between risk assessors, risk managers, consumers and other stakeholders regarding the occurrence of risk, factors that determine its occurrence, consequences and prevention measures and/or specific actions of all stakeholders in the agri-food chain. Communication in risk situations is a component of barriers to risk assessment and management, whose three components are:

1. Risk assessment
2. Risk management
3. Communication in risky situations.

Effective communication in risky situations can be achieved;

- Physical or health well-being of people
- Consumer confidence in food supply and regulatory systems
- Environmental Protection
- Improving the overall quality of life including socio-economic and psychological factors.

Internal or intrinsic properties of food quality[13] refer to:

4. Consumer health safety
5. Shelf life of the product and its sensory (organoleptic) properties
6. Reliability and practicality of the product

Consumer health safety is a basic and ultimate property of food quality5. If the food is not healthy, poisoning occurs in acute[38] or in chronic form. The following factors threaten consumer health safety[13]:

- Pathogenic microorganisms[39, 40]
- Toxic substances[41]
- Foreign objects
- Occurrences of natural disasters and catastrophes

The shelf life of a product and its sensory properties is second in importance to food quality. The expiration date is primarily related to the reliability of consumer health, ie microbiological spoilage of the food product. However, in some cases the shelf life may be related to the physical properties of food products[42], as well as to changes in the chemical composition and sensory properties of products[43].

Product reliability and practicality is an extremely important property of product quality from a consumer perspective. Namely, modern consumers are looking for a food product that they expect to be:

- healthy and good nutritional properties,
- good taste,

[5] Explained in detail in ch. 4.3. Sources of danger in the agri-food chain.

- easy to use,
- whose preparation does not take long,
- which has stable sensory properties even after opening the packaging, of course provided that it is stored in the conditions prescribed in the instructions for use and storage,
- and which is packed in practical packaging that allows its easy use.

Therefore, food producers invest great efforts and resources in research and development of products that will meet the demands of consumers[44, 45, 46].

In essence, the reliability and practicality of the product is the result of the first and second internal (intrinsic) attributes of the quality of the food product. However, the success of the sale of this food product depends on this internal attribute of quality, because if customers do not accept it, the return on investment in the development of this product will not be realized.

4.3 Sources of danger in agri-food chains

Sources of danger to human and animal health in agri-food chains can be;

- metabolic products of plants, animals and microorganisms,
- chemical and biological toxic substances from the environment,
- purposefully added food additives,
- and substances produced during food processing.

Although food is necessary for our body, if it is contaminated with pathogenic microbes or their toxins or other contaminants from the environment, in this case food can play a major role in the transmission or development of disease. Contamination of food with pathogenic microorganisms or toxic chemicals can cause a number of health problems. Food contamination is responsible for more than 200 diseases such as intestinal diseases and other foodborne diseases, and can lead to death. Of course, toxic components can be found in foods of animal and plant origin, as well as in higher fungi, which are used as a food source. Such toxic compounds can damage certain organs and systems, such as the skin, cardiovascular system, and can manifest systemic negative effects by binding to hormone receptors or affecting the nervous system. Food safety hazard refers to any product present in food that causes harmful effects on the health of consumers[47].

All sources of danger in the agri-food chain *(food hazards)* are divided into:

- biological,
- chemical,
- physical.

4.3.1 Sources of biological hazards in the agri-food chain

Some pathogenic bacteria and fungi, but also some viruses, prions and protozoa, contaminate food during production and processing, but also during its storage and transport before consumption. During their growth, these microorganisms can secrete various components, including toxins. Also, these organisms are responsible for the formation of some other harmful substances that can contaminate food after the breakdown of pathogens in the finished food or food product. Today, food is a global product and its transport takes place over long distances, and there are great opportunities for contamination during transport. Unfortunately, consumers and government food control agencies are aware of this only in developed countries, while countries do not have sufficient knowledge about foodborne diseases, despite the fact that there are millions of diagnosed cases of various forms of food poisoning worldwide[48, 49].[6]

Listeria monocytogenes, Campylobacter spp., Escherichia coli, Salmonella spp., Staphylococcus aureus, Bacillus cereus, Shigella sp., Shigella sp., Vibrio vulnificus and Vibrio parahaemolyticus, are among the most

[6] Cf. Chap. 1. Agricultural food chains →1.1. Introduction → Uruguay Round of negotiations → GATT

common and dangerous foodborne pathogens. In order to prevent food contamination with these pathogens, measures are being taken to control the microbiological safety of fresh raw materials of animal origin (milk, meat, eggs, fish and seafood, but also fruits and vegetables) and to monitor the technological process of processing raw materials into food products, preventing the so-called *cross-contamination*. This term refers to the contamination of food with undesirable and harmful substances, which may be naturally present, added during the process of production, processing and storage of food, or which reached the food accidentally simply by momentary carelessness.

Namely, equipment and surfaces in contact with food in the food industry can themselves become a substrate for the development of pathogenic microbes, which is known as *biofilm*. By definition, biofilm is a sessile community of bacteria and molds in deposits of complex sugars, and proteins that contain sugars and in which dust from the air is deposited. Biofilm is usually created on the border between two aggregate states. This is exactly the case in the food industry. Therefore, numerous preventive measures are implemented, and in addition to constant microbiological controls of control laboratories that must be carried out by each food manufacturer and prescribed by law and other legal acts of individual countries and the EU, the obligatory preventive measure is *washing and disinfection of equipment and work surfaces* in the food industry. and food distribution, including the retail sale of fresh meat, cured meat products, fresh fish and shellfish.

Today, the best results in preventing biofilm formation are achieved by the use of surfactants[7] and alkaline compounds for the treatment of work surfaces and equipment before washing and rinsing with water under pressure[50, 51].

4.3.2 Sources of chemical hazards in the agri-food chain

Certainly the most drastic epidemiological case of chemical poisoning in the food chain is the example of Minamata disease (syn. Minamata syndrome) which was recognized and described on May 1, 1956, and the epidemiological study was completed in early January 1957 under the leadership of Dr. sc. Shoji Kitamura, full professor at Kumamoto University School of Medicine in Japan[52]. Namely, the Japanese chemical company Chisso from its factory located near the city of Minamata released large amounts of methylmercury into the Minamata River in wastewater. As the river flows into the bay of the same name, which is rich in fish, mercury has accumulated in marine organisms and through the food chain has accumulated in humans, causing severe neurological disorders and even malformations in fetuses[53]. The next case was repeated five years later in Ontario, Canada, when the chemical company Dryden was found to have polluted the Wabigoon River ecosystem with approximately 10 tons of mercury between 1962 and 1970, and it is estimated that recovery of the ecosystem will take 50-70 years[54].

These are just two drastic examples of mercury poisoning of aquatic ecosystems that reaches fish and shellfish consumers through the food chain.

Sources of chemical hazards in the agri-food chain are:

- *Heavy metals*; with two drastic examples of contamination and food poisoning by heavy metals, specifically mercury, described above.
- *Food additives;* food colors, sweeteners, flavor enhancers, preservatives and antioxidants. Namely, although their maximum quantities in which they may be present in food products are strictly determined and controlled by the competent laboratories, in case of any non-compliance they can be a serious source of chemical danger to consumer health.
- *Residues of plant protection products;* the active substances of many plant protection products are neurotoxic and even potentially carcinogenic and some are under strict control and their actual carcinogenicity is still being investigated[55].

[7] Surfactants are substances that reduce the surface tension of water, ie reduce the forces acting on the interface between the two phases, which allows the formation of foam, creating an aqueous emulsion with liquids with which water does not mix (eg oil) and aqueous suspensions with substances which water does not otherwise dissolve (e.g. with fat). Surfactants are the main ingredients of detergents, industrial means for removing impurities by washing in water.

- *Mycotoxin residues;* which represent an increasing source of danger in the agri-food chain, especially in post-harvest management and storage of agricultural and food products.[8]
- Dioxins; which occur in the wild after large forest fires, and cases of dioxins entering the agri-food chain[9] are also known. Cases of intentional dioxin poisoning are also known to the public[10].

In any case, the sources of chemical hazards in the agri-food chain can only be controlled by strict preventive measures that include analysis of soil, water, agricultural raw materials that go into processing and, finally, finished food products.

4.3.3 Sources of physical danger in the agri-food chain

One of the drastic examples of sources of physical danger in the agri-food chain is the contamination of milk and dairy products, meat, fish, vegetables and grain crops with radionuclides ^{131}I, $^{134/137}Cs$, ^{90}Sr after the Chernobyl disaster on April 26, 1986. This has led to a ban on agricultural production on 265,000 ha in Belarus, 130,000 ha in Ukraine and 17,000 ha in Russia[56]. However, radionuclides do not reach the agri-food chain through nuclear disasters, but also through the use of mineral fertilizers, in which phosphorus is derived from phosphate ores that have a naturally elevated concentration of radionuclides that accumulate in the plant. transfer of natural radionuclides from soil to crop[57, 58, 59].

However, radionuclides are not the only source of physical danger in the agri-food chain, but they can also be pieces of glass or small metal and plastic objects, which can fall into the packaging of the food product before it is closed.

4.4 Incident prevention in agri-food chains

Incident prevention in agri-food chains takes place at three levels:

1. Providing the necessary quantities of food, in order to achieve *food security* of the population of each country or region[11]
2. Ensuring hygienically and healthily correct food, ie *food safety*, the consumption of which will not cause acute poisoning, nor chronic diseases of those who consume it.[11]
3. *Food defense* measures

However, the main tool used at all three levels is traceability in agri-food chains.[12]

4.4.1 Food security of the population of each country or region

The most accurate definition of food security of the population of each country or region was given at the World Food Summit in 1996 and it reads:

"Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their nutritional needs and inclinations for an active and healthy life."

For food security to exist, four elements must be met[60]:

1. *Availability of food:* Availability of sufficient quantities of food of adequate quality, supplied by domestic production or import (including food aid).
2. *Access to food:* Access of individuals to adequate resources (rights) to acquire adequate food. A right is defined as a set of all goods over which a person can establish control over the legal, political, economic and social organization of the community in which he lives (including traditional rights such as access to shared resources).

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[8] *See* ch. 1. Agricultural food chains → 1.4. Post-harvest management of agricultural products in agri-food chains

[9] Link: https://www.europarl.europa.eu/news/en/headlines/society/20110121STO12289/dioxin-contamination-in-germany-meps-call-for-stricter-controls-penalties

[10] Link: https://www.newscientist.com/article/dn17570-skin-growths-saved-poisoned-ukrainian-president/

[11] *See* ch. 1. Agricultural food chains → 1.2. What are agri-food chains and who are the stakeholders in them?

[12] *See* ch. 1. Agricultural food chains → 1.6. Traceability in the agri-food chain

3. *Use:* The use of food through proper nutrition, clean water, sanitation and health care to achieve a state of nutritional well-being in which all physiological needs are met. This reveals the importance of non-food inputs in food safety.
4. *Stability:* It means that the population, household or individual must have access to adequate food at all times. The risk of losing access to food as a result of sudden shocks (eg economic or climate crisis) or cyclical events (eg seasonal food insecurity) should be kept to a minimum. Therefore, the concept of stability can refer to both the availability and the access dimension of food safety.

Unfortunately, food insecurity is present in many parts of the world today[61], and the main reason for this is global climate change, which particularly affects third world countries[62]. If climate change is added to the loss of natural resources, especially the soil necessary for food production[63, 64], the threat of world hunger becomes a certain scenario[65].

4.4.2 Hygienic and health food safety

Hygienic and health safety of food is essentially the biological, chemical and physical status of food that allows its consumption without the risk of injury, disease or mortality[66].

However, the international term 'food safety' includes culture, organization and social climate, ie the overall production, economic, technological, legal and social conditions in which food is produced, distributed and consumed without or with a minimum level of risk to consumer health[67]. As food security is a strategic issue extremely important for the national security of each country and region, on 28 January 28 2002, the European Union adopted Regulation No 178/2002 of the European Parliament and of the Council laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety[68]. Based on this document, the European umbrella organization in charge of proposing, coordinating and implementing food safety policy is the European Food Safety Authority (EFSA).[13] Food agencies in all EU member states work closely with this organization because it is known that all provisions of the European Parliament and the Council of Europe, as well as European Commission directives have binding and direct implementation in the legislation of EU member states. As EFSA was founded with the aim of being a source of scientific advice and communication on the risks associated with the food chain, its official journal *EFSA journal*[14] publishes a number of analyzes, opinions, recommendations and studies available to every EU and global citizen.

At the United Nations level, the same activities are carried out by the Food and Agriculture Organization (FAO)[15], which operates mainly in third world countries through education and technical assistance. In the United States, it is the US Food and Drug Administration (FDA)[16] and the United States Department of Agriculture (USDA).[17]

In any case, despite all the concerns about food safety in terms of hygiene and health, one thing is certain, and that is that "there is no food security without food safety" [18][69].

4.4.3 Food defence

Food is a strategic product, so today more and more attention is paid to the defense aspects of the protection of agri-food chains within food systems. This term is known as food defence and represents the adoption and implementation of all measures of protection against *agroterrorism and food terrorism*, in order to ensure protection against any intentional food poisoning and the use of contaminated food as a weapon[70]. Namely,

[13] Link: https://www.efsa.europa.eu/en/aboutefsa

[14] *EFSA* journal [Online ISSN: 1831-4732] can be found at: https://efsa.onlinelibrary.wiley.com/journal/18314732. The journal is indexed in the reference database of scientific journals Journal Citation Reports in the field of 'Food Science & Technology' in which in 2020 it is ranked as 53 out of 144 journals and belongs to the second quartile (Q2).

[15] Link: http://www.fao.org/food-safety/en/

[16] Link: https://www.fda.gov/food

[17] Link: https://www.usda.gov/topics/food-and-nutrition

[18] *Orig.* ' There is no food security without food safety'

as strange as it may seem to the average person, the fact that the whole story is not harmless is shown by the fact that a manual for training members of the terrorist organization al-Qaeda was found during a search of an apartment in Manchester (UK). Lesson 16 describes how contaminated food can be used as a weapon[71]. However, apart from intentional contamination of food caused by terrorist activity, often with a political motive, perhaps the most pervasive form of intentional contamination is to improve profits, ie to harm competition or to retaliate against competitors. In any case, the 'motives' of mentally disturbed people and local extremists should not be ruled out[72].

The question is how to fight agro-terrorism and food terrorism?

The answer is simple; traceability and strengthening of food safety culture.

Therefore, each defense strategy essentially combines all the principles of 'food security', 'food safety' and the basic tool by which it is implemented is traceability in agri-food chains. Food defense is an extremely important security issue and must be an integral part of any well-designed *agri-food system*.

4.5 What are agri-food systems?

Agri-food systems, in terms of specifics that may relate to the type of product and/or the method of production and the number of stakeholders, become components of food systems. Although there is no single definition of food systems[73], they are determined by a range of activities carried out on the establishment of agri-food chains, food security activities and other activities such as environmental protection and biodiversity[74]. What is being sought is the establishment of an *elastic, flexible and resilient* food system that is able to fulfill its functional goal – to ensure food safety – despite disturbances and shocks, whether economic or natural. The resilience of such a system consists of the following components:

- Robustness (impact resistance)
- Redundancy (ability to absorb interference)
- Flexibility or speed (recovery potential for lost food safety)
- Resourcefulness or adaptability (percentage of food safety lost: recovered)

However, the highest level in the organization of any system, including the food or agri-food system, is *sustainability*[75].

According to the FAO, a *sustainable food system* is one that provides food security for all, without compromising the economic, social and environmental foundations for creating food security for future generations[76, 77].

Unfortunately, today's food systems are definitely not sustainable. There are the following reasons for this:

- Food supply based solely on market economic models that depend on steady growth in consumption.
- The agri-food system is dominated by a small number of large global companies that tirelessly strive for growth and monopoly, while eliminating trends toward sustainable and healthy food. This puts pressure on producers to produce food at low prices, and this is possible only with the use of agrochemicals and increasing the consumption of fossil fuels.
- High flow of production and consumption in the supply chain inevitably leads to waste, especially by retailers and consumers. This reduces the resilience needed to cope with global shocks and major disturbances caused by the effects of climate change, but also plant pests and diseases.
- Globalization of the food and agricultural raw materials market, which theoretically predicts poverty reduction due to the overall strengthening of international trade, in practice often redirects local agriculture and land use for food exports to developed countries has led to poor outcomes such as deforestation, pollution and biodiversity loss.
- Some of the positive policy measures of individual government countries, such as subsidies for agriculture or incentives for the food industry, aimed at addressing environmental and health issues, often fail due to conflicts with the interests of large corporations.
- The system of sanctioning environmental and health incidents is almost inefficient due to the activities of various lobby interest groups (individual stakeholders) in agri-food chains.

- Research and policy on the agri-food industry have a reductionist character that does not recognize the unbreakable link between environmental health and human health.

When we add to this the intensifying and faster climate changes and catastrophes they bring[78, 79], as well as the latest pandemic of covid-19 virus[80] and also future pandemics, it is clear that radical changes in production methods and food consumption are needed[81]. Therefore, research and development of new sustainable technologies and education play a major role in the development of sustainable food systems based on sustainable agri-food chains[82].

Bibliography

[1] Giovannucci, D., Satin, M. (2000) Food Quality Issues: Understanding HACCP and Other Quality Management Techniques. A Guide to Developing Agricultural Markets and Agro-Enterprises. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/17702

[2] Anderson, J. C., Rungtusanatham, M., Schroeder, R.G. (1994) A Theory of Quality Management Underlying the Deming Management Method. The Academy of Management Review, 19, 472–509. https://www.jstor.org/stable/258936

[3] Civille, G. V. (1990) Food quality: consumer acceptance and sensory attributes. Journal of Food Quality, 14, 1–8., https://doi.org/10.1111/j.1745-4557.1991.tb00044.x

[4] Potter, N. N., Hotchkiss, J. H. (1995) Food Science. Fifth Edition. Springer Science+Business Media, New York. https://doi.org/10.1007/978-1-4615-4985-7

[5] Leitzmann, C. (1993) Food Quality—Definition and a Holistic View. In: Sommer H., Petersen B., v. Wittke P. (eds) Safeguarding Food Quality. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-78025-7_2

[6] Bermudez, O. I. (2016) Ethnic Foods. Chapter in book: Encyclopedia of Food and Health. Caballero, B., Finglas, P.M., Toldrá, F. (eds.). Academic Press, Elsevier. 563–568. https://doi.org/10.1016/B978-0-12-384947-2.00263-4

[7] Featherstone, S. (2015) Kosher and Halal Food Regulations. A Complete Course in Canning and Related Processes. Woodhead Publishing, Elsevier. 63–68. https://doi.org/10.1016/B978-0-85709-677-7.00003-7

[8] Arihara, K. (2014) Functional Foods. Chapter in book: Encyclopedia of Meat Sciences (Second Edition). Dikeman, M., Devine, C. (eds.). Academic Press, Elsevier. 32–36. https://doi.org/10.1016/B978-0-12-384731-7.00172-0

[9] Tur, J. A., Bibiloni, M. M. (2016) Functional Foods. Chapter in book: Encyclopedia of Food and Health. Caballero, B., Finglas, P. M., Toldrá, F. (eds.). Academic Press, Elsevier. 157–161. https://doi.org/10.1016/B978-0-12-384947-2.00263-4

[10] Hall, C. M., Sharples, L. (2003) The consumption of experiences or the experience of consumption? An introduction to the tourism of taste. Chapter in book: Food Tourism Around The World. Hall, C.M., Sharples, L., Mitchell, R., Macionis, N., Cambourne, B. (eds.). Butterworth-Heinemann, Elsevier. 1–24. https://doi.org/10.1016/B978-0-7506-5503-3.50004-X

[11] Bloksma, J., Northolt, M., Huber, M., van der Burgt, G. J., van de Vijver, L. (2007) A new food quality concept based on life processes. Chapter in book: Handbook of Organic Food Safety and Quality. Cooper, J., Niggli, U., Leifert, C. (eds.). Woodhead Publishing. 53–73. https://doi.org/10.1533/9781845693411.1.53

[12] Knura, S., Gymnich, S., Rembialkowska, E., Petersen, B. (2007) Agri-food production Chain. Chapter in book: Safety in the agri-food chain. Luning, P. A., Devlieghere, F., Verhé, R. (eds.). Wageningen Academic Publishers. The Netherlands. 19–65.

[13] Luning, P. A., Marcelis, W. J. (2020) Food quality attributes. Chapter in book: Food Quality Management: Technological and managerial principles and practices. Wageningen Academic Publishers, The Netherlands. 52–65.

[14] Britwum, K., Bernard, J. K., Albrecht, S. E. (2021) Does importance influence confidence in organic food attributes? Food Quality and Preference, 87, 104056. https://doi.org/10.1016/j.foodqual.2020.104056

[15] Russo, C., Simeone, M., Perito, M.A. (2020) Educated Millennials and Credence Attributes of Food Products with Genetically Modified Organisms: Knowledge, Trust and Social Media. Sustainability, 12, 8534. https://doi.org/10.3390/su12208534

[16] Rudenko, L., Matheson, J. C., Sundlof, S. F. (2007) Animal cloning and the FDA – the risk assessment paradigm under public scrutiny. Nature Biotechnology, 25, 39–43. https://doi.org/10.1038/nbt0107-39

[17] Eddison, J. C. (2003) Animal welfare. Chapter in book: The Agricultural Notebook (20th Edition). Soffe, R. (ed.). Primrose McConnell's, Blackwell Science & Blackwell Publishing. 431–440.

[18] Gallo, A., Accorsi, R., Goh, A., Hsiao, H., Manzini, R. (2021). A traceability-support system to control safety and sustainability indicators in food distribution. Food Control, 124, 107866. https://doi.org/10.1016/j.foodcont.2021.107866

[19] Luning, P. A., Marcelis, W. A. (2009) A food quality management research methodology integrating technological and managerial theories. Trends in Food Science & Technology, 20, 35–44. https://doi.org/10.1016/j.tifs.2008.09.013

[20] Morgan, M. T., Haley, T. A. (2013) Design of Food Process Controls Systems. Chapter in book: Handbook of Farm, Dairy and Food Machinery Engineering (Second Edition). Kutz, M. (ed.). Academic Press, Elsevier. 475–540. https://doi.org/10.1016/C2010-0-67839-4

[21] Huang, Y. (2013) Automatic process control for the food industry: an introduction. Chapter in book: Robotics and Automation in the Food Industry, Current and Future Technologies. Caldwell, D. G. (ed.). Woodhead Publishing. 3–20. https://doi.org/10.1533/9780857095763.1.3

[22] Bargańska, Ż., Namieśnik, J. (2010) Pesticide Analysis of Bee and Bee Product Samples. Critical Reviews in Analytical Chemistry, 40, 159–171. https://doi.org/10.1080/10408347.2010.490484

[23] Rahman, M. S. (ed.) (2007) Handbook of Food Preservation. CRC Press, Taylor & Francis Group. 3–939.

[24] Marsh, K., Bugusu, B. (2007) Food Packaging – Roles, Materials, and Environmental Issues. Journal of Food Science, 72, 39–55. https://doi.org/10.1111/j.1750-3841.2007.00301.x

[25] Molina-Besch, K., Wikström, F., Williams, H. (2019) The environmental impact of packaging in food supply chains – does life cycle assessment of food provide the full picture? The International Journal of Life Cycle Assessment, 24, 37–50. https://doi.org/10.1007/s11367-018-1500-6

[26] Bagherzadeh, M., Inamura, M., Jeong, H. (2014) Food Waste Along the Food Chain. OECD Food, Agriculture and Fisheries Papers, 71. OECD Publishing, Paris. https://doi.org/10.1787/5jxrcmftzj36-en
[27] Varun, S. A., Nautiyal H. (2016) Environmental Impacts of Packaging Materials. In: Muthu S. (eds) Environmental Footprints of Packaging. Environmental Footprints and Eco-design of Products and Processes. Springer, Singapore. https://doi.org/10.1007/978-981-287-913-4_5
[28] Ncube, L. K., Ude, A. U., Ogunmuyiwa, E. N., Zulkifli, R., Beas, I. N. (2020) Environmental Impact of Food Packaging Materials: A Review of Contemporary Development from Conventional Plastics to Polylactic Acid Based Materials. Materials, 13, 4994. https://doi.org/10.3390/ma13214994
[29] European Food Safety Authority (2012) Report of ESCO WG on non-plastic Food Contact Materials. Supporting Publications 139. pp- 63. www.efsa.europa.eu
[30] de Koeijer, B. B., Wever, R., Henseler, J. (2017) Realizing Product-Packaging Combinations in Circular Systems: Shaping the Research Agenda. Packaging Technology and Science, 30, 443–460. https://doi.org/10.1002/pts.2219
[31] Rösler, F., Kreyenschmidt, J., Ritter, G. (2021) Recommendation of Good Practice in the Food-Processing Industry for Preventing and Handling Food Loss and Waste. Sustainability, 13, 9569. https://doi.org/10.3390/su13179569
[32] Betz, A., Buchli, J., Göbel, C., Müller, C. (2015) Food waste in the Swiss food service industry – Magnitude and potential for reduction. *Waste Management*, 35, 218-226. https://doi.org/10.1016/j.wasman.2014.09.015
[33] Leverenz, D., Moussawel, S., Maurer, C., Hafner, G., Schneider, F., Schmidt, T., Kranert, M. (2019) Quantifying the prevention potential of avoidable food waste in households using a self-reporting approach. Resources, Conservation & Recycling, 150, 104417. https://doi.org/10.1016/j.resconrec.2019.104417
[34] Porpino, G., Parente, J., Wansink, B. (2015) Food waste paradox: antecedents of food disposal in low income households. International Journal of Consumer Studies, 39, 619–629. https://doi.org/10.1111/ijcs.12207
[35] Alamar, M. C., Falagán, N., Aktas, E., Terry, L. A. (2018) Minimising food waste: a call for multidisciplinary research. Journal of the Science of Food and Agriculture, 98, 8–11. https://doi.org/10.1002/jsfa.8708
[36] Sadhukhan, J., Dugmore, T. I. J, Matharu, A., Martinez-Hernandez, E., Aburto, J., Rahman, P. K. S. M., Lynch, J. (2020) Perspectives on "Game Changer" Global Challenges for Sustainable 21st Century: Plant-Based Diet, Unavoidable Food Waste Biorefining, and Circular Economy. Sustainability, 12, 1976. https://doi.org/10.3390/su12051976
[37] FAO and WHO (2016) Risk Communication Applied To Food Safety Handbook. Food Safety and Quality Series, 2, Food And Agriculture Organization of the United Nations, Rome 2016. https://www.who.int/foodsafety/RiskCommunication-FoodSafety.pdf
[38] Hughes, C., Gillespie, I. A., O'Brien, S. J. (2007) Foodborne transmission of infectious intestinal disease in England and Wales, 1992–2003. Food Control, 18, 766–772. https://doi.org/10.1016/j.foodcont.2006.01.009
[39] European Food Safety Authority (EFSA) — Working Group on Developing Harmonised Schemes for Monitoring. Members of the Working Group were as follows: S. Bronzwaer (Chairman), F. Aarestrup, A. Battisti, B. Bengtsson, S. Piriz, Duran, H. D. Emborg, G. Kahlmeter, D. Mevius, G. Regula, P., Sanders, C. Teale, D. Wasyl, K. De Smet, J. Torren Edo, P. Tüll, H. Deluyker, P. Mäkelä. (2008) Harmonised monitoring of antimicrobial resistance in *Salmonella* and *Campylobacter* isolates from food animals in the European Union. Clinical Microbiology and Infection, 14, 522–533. https://doi.org/10.1111/j.1469-0691.2008.02000.x
[40] Kovačić, A., Carev, M., Tripković, I., Srečec, S., Šiško-Kraljević, K. (2015) Comparison of Campylobacter jejuni pulsotypes isolated from humans and poultry in Split and Dalmatia County, Croatia. International Journal of Environmental Health Research, 25, 10-20. Doi: https://doi.org/10.1080/09603123.2014.893565
[41] Harada, M., Akagi, H., Tsuda, T., Kizaki, T., Ohno, H. (1999) Methylmercury level in umbilical cords from patients with congenital Minamata disease. The Science of the Total Environment, 234, 59-62.
[42] Janjatović, D., Benković, M., Srečec, S., Ježek, D., Špoljarić, I., Bauman, I. (2012) Assesment of powder flow characteristics in incoherent soup concentrates. Advanced Powder Technology, 23, 620–631. https://doi.org/10.1016/j.apt.2011.07.003
[43] Srečec, S., Rezić, T., Šantek, B., Marić, V. (2008) Influence of Hops Pellets Age on α -acids Utilization and Organoleptic Quality of Beer. Agriculturae Conspectus Scientificus, 73, 103–107.
[44] Benković, M., Srečec, S., Špoljarić, I., Mršić, G., Bauman, I. (2013) Flow properties of commonly used food powders and their mixtures. Food and Bioprocess Technology, 6, 2525–2537. https://doi.org/10.1007/s11947-012-0925-3
[45] Benković, M., Srečec, S., Špoljari, I., Mršić, G., Bauman, I. (2015) Fortification of instant coffee beverages – influence of functional ingredients, packaging material and storage time on physical properties of newly formulated, enriched instant coffee powders. Journal of the Scienceo of Food and Agriculture, 95, 2607–2618. https://doi.org/10.1002/jsfa.6989
[46] Benković, M., Belščak-Cvitanović, A., Bauman, I., Komes, D., Srečec, S. (2017) Flow properties and chemical composition of carob (*Ceratonia siliqua* L.) flours as related to particle size and seed presence. Food research international, 100, 211–218. https://doi.org/10.1016/j.foodres.2017.08.048
[47] Kumar Singh, P., Pratap Singh, R., Singh, P., Lakhan Singh, R. (2019) Food Hazards: Physical, Chemical, and Biological. Chapter in book: Food Safety and Human Health. Singh, L., Mondal, S. (eds.). Academic Press, Elsevier. 15–65. https://doi.org/10.1016/B978-0-12-816333-7.00002-3
[48] Martinović, T., Andjelković, U., Šrajer Gajdošik, M., Rešetar, D., Josić, D. (2016) Foodborne pathogens and their toxins. Journal of Proteomics, 146, 226–235. https://doi.org/10.1016/j.jprot.2016.04.029
[49] Wang, S., Weller, D., Falardeau, J., Strawn, L.K., Mardones, F. O., Adell, A. D., Moreno Switt, A. I. (2016). Foodsafety trends: from globalization of whole genomesequencing to application of new tools to prevent foodborne diseases. Trends in Food Science & Technology, 57, 188–198. https://doi.org/10.1016/j.tifs.2016.09.016
[50] Campana, R., Casettari, L., Fagioli, L., Cespi, M., Bonacucina, G., Baffone, W. (2017) Activity of essential oil-based microemulsions against *Staphylococcus aureus* biofims developed on stainless steel surface in different culture media and growth conditions. International Journal of Food Microbiology, 241, 132–140. https://doi.org/10.1016/j.ijfoodmicro.2016.10.021
[51] Schirone, M., Visciano, P., Tofalo, R., Suzzi, G. (2017) Editorial: Biological Hazards in Food. Frontiers in Microbiology, 7, 2154. https://doi.org/10.3389/fmicb.2016.02154
[52] Yorifuji, T. (2020) Lessons from an early-stage epidemiological study on Minamata disease. *Journal of Epidemiology*, 30, 12–14. https://doi.org/10.2188/jea.JE20190089

[53] Takeuchi, T. (1982) Pathology of Minamata disease. With special reference to its pathogenesis. Acta Pathologica Japonica, 32, Suppl 1, 73–99.
[54] Mosa, A., Duffin, J., (2017) The interwoven history of mercury poisoning in Ontario and Japan. Canadian Medical Assotiation Journal (CMAJ), 189, E213–5. https://doi.org/10.1503/cmaj.160943
[55] Torretta, V., Katsoyiannis, I. A., Viotti, P., Rada, E. C. (2018) Critical Review of the Effects of Glyphosate Exposure to the Environment and Humans through the Food Supply Chain. Sustainability, 10, 950. https://doi.org/10.3390/su10040950
[56] Nesterenko, A. V., Nesterenko, V. B., Yablokov, A. V. (2009) Radiation Protection after the Chernobyl Catastrophe. Chernobyl's Radioactive Contamination of Food and People. Annals of the New York Academy of Sciences, 1181, 287–327. https://doi.org/10.1111/j.1749-6632.2009.04836.x
[57] Ilori, A. O., Chetty, N. (2020) Soil-to-crop transfer of natural radionuclides in farm soil of South Africa. Environmental Monitoring and Assessment, 192, 775. https://doi.org/10.1007/s10661-020-08756-7
[58] Saueia, C. H. R., Mazzilli, B. P. (2006) Distribution of natural radionuclides in the production and use of phosphate fertilizers in Brazil. Journal of Environmental Radioactivity, 89 229–239. https://doi.org/10.1016/j.jenvrad.2006.05.009
[59] El-Bahi, S. M., Sroor, A., Gehan Y. Mohamed, El-Gendy, N. S. (2017) Radiological impact of natural radioactivity in Egyptian phosphate rocks, phosphogypsum and phosphate fertilizers. Applied Radiation and Isotopes, 123, 121–127. https://doi.org/10.1016/j.apradiso.2017.02.031
[60] FAO (2006) Food Security. Policy Brief, 2, 1–4.
[61] http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf
[62] Horton, P. (2017) We need radical change in how we produce and consume food. *Food Security*, 9,1323–1327. https://doi.org/10.1007/s12571-017-0740-9
[63] Tirado, M. C., Clarke, R., Jaykus, L. A., McQuatters-Gollop, A., Frank, J. M. (2010) Climate change and food safety: A review. Food Research International, 43, 1745–1765. https://doi.org/10.1016/j.foodres.2010.07.003
[64] Pozza, L. E., Field, D. J. (2020) The science of Soil Security and Food Security. Soil Security, 1, 100002. https://doi.org/10.1016/j.soisec.2020.100002
[65] Winkler, K., Fuchs, R., Rounsevell, M., Herold, M. (2021) Global land use changes are four times greater than previously estimated. Nature Communications, 12, 2501. https://doi.org/10.1038/s41467-021-22702-2
[66] Herrington, G. (2020) Update to limits to growth. Comparing the World3 model with empirical data. Journal of Industrial Ecology, 25, 614–626. https://doi.org/10.1111/jiec.13084
[67] Oyarzabal, O. A., Van Renterghem, B. B. (2020) The Meaning of Food Safety. Food Safety Magazine (eMagazine April 16, 2020). https://www.food-safety.com/articles/6545-the-meaning-of-food-safety
[68] Sharman, N., Wallace, C. A., Jespersen, L. (2020) Terminology and the understanding of culture, climate, and behavioural change – Impact of organisational and human factors on food safety management. Trends in Food Science & Technology, 96, 13–20. https://doi.org/10.1016/j.tifs.2019.12.005
[69] EC (2002) Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. http://data.europa.eu/eli/reg/2002/178/2021-05-26
[70] FAO (2019) The Future of Food Safety: There is no Food Security without Food Safety. CA4289EN/1/04.19. http://www.fao.org/3/ca4289en/CA4289EN.pdf
[71] Moerman, F. (2018) Food Defense. Chapter in book: Food Control and Biosecurity – A volume in Handbook of Food Bioengineering. Holban, A.M., Mihai, A. (eds.). Academic Press, Elsevier. 135–223. https://doi.org/10.1016/B978-0-12-811445-2.00005-2
[72] Federal Bureau of Investigation (FBI) 2007. Assassinations using poisons and cold steel. Lesson 16, Manchester Terrorist Training Manual, Behavioural Analysis Program, Operational Training Unit, Counterintelligence Division, FBI Headquarters, United States, UK/BM-153-160.
[73] Mitenius, N., Kennedy, S. P., Busta, F. F. (2014) Food Defense. Chapter in book: Food Safety Management – A Practical Guide for the Food Industry. Motarjemi, Y., Lelieveld, H. (eds.). Academic Press, Elsevier. 937–957. https://doi.org/10.1016/B978-0-12-381504-0.00035-4
[74] Brouwer, I.D., McDermott, J., Ruben, R. (2020) Food systems everywhere: Improving relevance in practice. Global Food Security, 26, 100398. https://doi.org/10.1016/j.gfs.2020.100398
[75] UNEP (2016) Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., Hajer M. https://www.resourcepanel.org/reports/food-systems-and-natural-resources
[76] Stefanovic, L., Freytag-Leyer, B., Kahl., J. (2020) Food System Outcomes: An Overview and the Contribution to Food Systems Transformation. Frontiers in Sustainable Food Systems, 4, 546167. https://doi.org/10.3389/fsufs.2020.546167
[77] FAO (2018) Sustainable food systems: concept and framework. Brief. Rome. http://www.fao.org/3/ca2079en/CA2079EN.pdf
[78] Porfirio, L. L., Newth, D., Finnigan, J. J., Cai, Y. (2018) Economic shifts in agricultural production and trade due to climate change. Palgrave Communications, 4, 11. https://doi.org/10.1057/s41599-018-0164-y
[79] Porfirio, L. L., Newth, D., Finnigan, J. J., Cai, Y. (2018) Economic shifts in agricultural production and trade due to climate change. Palgrave Communications, 4, 11. https://doi.org/10.1057/s41599-018-0164-y
[80] Girardin, C. A. J., Jenkins, S., Seddon, N., Allen, A., Lewis, S. L., Wheeler, C. E., Griscom, B. W., Malhi, Y. (2021) Nature-based solutions can help cool the planet – if we act now. Nature, 593, 191–194. https://doi.org/10.1038/d41586-021-01241-2
[81] Cullen, M.T. (2020) COVID-19 and the risk to food supply chains: How to respond?. FAO, Rome. https://doi.org/10.4060/ca8388en
[82] Horton, P. (2017) We need radical change in how we produce and consume food. *Food Security*, 9,1323–1327. https://doi.org/10.1007/s12571-017-0740-9
[83] Pardey, P. G., Chan-Kang, C., Dehmer, S. P., Beddow, J. M. (2016) Agricultural R&D is on the move. Nature, 537, 301–303. https://doi.org/10.1038/537301a

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CHAPTER 5

Consumer perception of food quality and safety

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5.1 Introduction

Increased interest in the issue of food quality and safety is associated with increased demand as a reflection of changes in the content and meaning of food supply chains. In fact, it is a series of qualitative changes faced by the agri-food complex as a result of the need to establish competitive patterns of competition in the sector. Namely, as the final front of consumption, food consumers represent a key reference point that defines the concept of food quality, and which is very closely related to the perception of safety for the same. From the consumer's point of view, in fact, several aspects contribute to defining the quality of a food product: it is not only internal qualities such as taste and other organoleptic properties, but also external factors such as origin and labeling[1]. Also, the quality and safety of food are the subject of public debate, ie a key factor that defines food policy and industry. Namely, all these aspects draw public attention to the issue of food safety and quality. It is not surprising that food quality safety assumes a prominent place in the political agenda, as well as in the sphere of consumer behavior. Taking all this into account, it could be said that the consumer is a pivotal component that in its maturation has become critical, demanding and picky when it comes to food. Therefore, the issue of quality and safety is the basis of differentiation policies, ie without such an approach it is impossible to imagine a modern competitive company that produces and offers food in a highly saturated and sensitive food market. Differentiation or the way of finding a whole range of prominent product features related to the designations of its origin or the way or technology of production that may suggest certain environmental or ethical aspects, creates a basic assumption of the concept of quality. Labeling or branding are the strongest tools that contribute to successful differentiation, and this is supported by research that confirms that consumers always check when buying whether a product has any labels that suggest quality and thus guarantee them certain characteristics[2].

5.2 Consumer awareness of food quality and safety

There are many ways in which the concept of food quality is defined, and analogously its safety. It is a common opinion that quality has its objective and subjective dimension. The objective dimension of food quality refers to the physical characteristics built into the product and is of interest to primary producers, processors, food technologists and the like. Subjective quality is the quality perceived by consumers and

influenced by different product characteristics. The relationship between these two dimensions is the essence of the economic importance of food quality, ie this link is the starting point for food producers to optimally define the physical characteristics of products in accordance with consumer preferences. In other words, it is a way of adapting products and marketing strategies to the real needs and desires of market segments. In this sense, food quality is a parameter of market competitiveness for its producers.

The subjective dimension of food quality as a way of defining consumer preferences actually represents the forms of motives for buying and the values associated with them. Responding to individual product properties has significant consequences on consumer expectations, ie the values that consumers seek and expect have an impact on achieving the desired dimensions of quality and the way in which different attributes are perceived and assessed. A process that, based on product properties and expected quality, ultimately leads to the motive of purchase[3]. In the subjective context, quality is defined not only in accordance with the functional needs of the consumer, but also the needs related to the sphere of his social, political, cultural, ethical or environmental relations[4]. From a consumer perspective, food quality can be viewed as a set of specific properties that a product should have in order to meet their expectations. These expectations need to be taken into account in terms of realizing immediate and future benefits, including the impact on health and quality of life in general[5]. The perception of food quality by the consumer is the result of his previous experience and knowledge of the product[6], and does not necessarily stem from rational premises. Namely, the perception of quality can be explained in accordance with the attitudes or beliefs of consumers based on their cultural status or socio-economic position in society. Thus, it is clear that no matter how the consumer is motivated, purchasing decisions will depend on his food patterns as a consequence of socio-economic conditioning. Therefore, in addition to the purely economic dimension, the perception of food quality is conditioned by health motives that do not have to be purely personal, but can be linked to concern for general ecological balance, or the impact of food production on the environment and people in general[7]. Very often the quality of food is associated with its geographical origin. The effect of geographical origin or country of origin is important in understanding and interpreting local food production, and consumers perceive such products through the overall dimension of quality. Evidence shows that consumers see an opportunity to be faithful to locally produced food products[8], that is, consumers recognize the superiority of the characteristics of locally produced products based on the effect of proven origin. This feeling can be considered in a way a reflection of a kind of consumer ethnocentrism, or a kind of emotional local patriotic dimension of consumer behavior[9]. Therefore, this irrational consumer status allows small and / or local producers in particular to better counter large systems that base their competitive advantage on economic resilience based primarily on economies of scale and marginal costs that allow them ideal profit margins. Previous research has shown that the commitment to locally produced products in the field of food production may explain different aspects of purchasing behavior and consumer attitudes towards imports in relation to domestic products[10].

Consumer awareness of food safety and its nutrition itself is linked to health and a healthy lifestyle. To avoid any health risk resulting from improper food consumption, consumers adjust their behavior based on awareness of eating habits and the way food is used. At the same time, there is public awareness of the role of diet in contributing to health. What people buy and eat and the way they manage food depends not only on the individual, but also on social, cultural, economic and environmental factors. Food safety is one of the most important public health issues in the world. Food quality and safety are critical to consumers and are an integral part of all food industry programs. Consumer education has also been identified as a key element as consumers also have a role to play in maintaining food safety throughout the food chain. Namely, they have the right to express their opinion on food control procedures, standards and activities used and implemented within the food supply chain, while consumers can play an important role in ensuring food safety and quality. On the other hand, the ultimate responsibility for implementing and achieving appropriate levels of food safety quality lies with the food industry, which oversees food production and processing, from raw materials to the finished product. Since food companies, in accordance with the defined concept of food quality, are highly dependent on consumer satisfaction, they must continuously invest in the development of safety aspects of their products. It is therefore in their interest to establish and manage controls that ensure that their products truly meet consumer expectations for safety and quality.

Due to all the above, the food production sector must work closely with the scientific sector, monitor the development of technology, invest and develop its logistics network and management disciplines required for the operation of the food supply system. Food producers must be involved in the process of setting standards at national and international level. They are obliged to provide their knowledge of the food supply system in this process in order to guarantee its efficiency and effectiveness and to ensure that it results in the supply of safe and quality products. This involvement is beneficial to consumers and society, as well as to industry.

To ensure safe products, the management of the food industry requires an organized way of defining and controlling the relationship of critical factors in a comprehensive food supply system, including product research and development, production and distribution, and consumer satisfaction. Quality assurance includes the development, organization and implementation of various activities aimed at maintaining and / or improving product safety and quality. This process begins with product development and continues through the selection and procurement of raw materials, and through processing, packaging, distribution and especially marketing.

5.2.1 Types of food quality

The basis for the classification of food quality arises from the basic difference between the concepts of subjective and objective food quality because such differentiation is important precisely because of the understanding and better interpretation of food quality from a consumer perspective[6]. In fact, the subjective quality of food is a factor that predominantly influences marketing decisions, because it is exclusively consumer-oriented. In addition to the product itself, the consumer may be affected by other factors such as the situation at the time of purchase, price or method of distribution. According to Brunsø et al[11], four types of food quality can be distinguished (Figure 1).

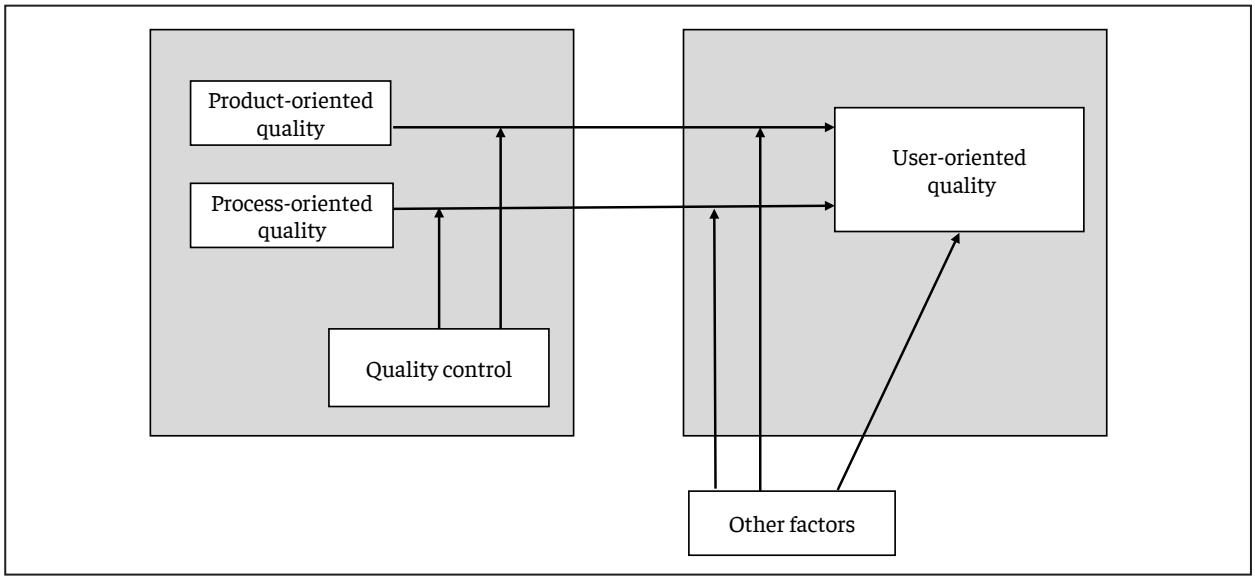

Figure 1. *Food quality types*
Source: Brunsø et al., 2002

Product-oriented quality encompasses all aspects of a physical product that together provide an accurate description of a particular food product. Examples of product quality are the percentage of fat and muscle mass of meat, the content of cells in milk, the starch content in potatoes and the strength of alcohol in beer.

Quality oriented to the process of production and processing includes the way in which the food product is produced. Whether the use of pesticides was avoided in primary production, ie organic production, or whether there was no growth inhibition, ie production was carried out in accordance with animal welfare regulations, etc. Descriptions based on these and similar production and processing aspects provide infor-

mation on the process used to create the final product, and these aspects do not necessarily affect the physical properties of the product.

The third type of food quality is quality control, which is defined as the standard that a product must meet in order to be approved for a certain quality class (e.g. the standard for egg weight for different sizes and the like). Furthermore, quality certification schemes such as ISO 9000 mainly deal with quality control. Quality control therefore deals with compliance with specific standards for product and process quality, regardless of the level at which they are defined. It can be said that product quality and process-oriented quality deal with the level of quality, while quality control deals with the dispersion of quality around a predetermined level.

Finally, user-centered quality is a subjective perception of quality from the user's point of view; the user may be an end user or an indirect user in the food chain, e.g a retailer.

Product-oriented quality, process-oriented quality and quality control can also be said to represent objective quality, as they can be determined by measuring and documenting aspects of the product and production process, and several such measurements of the same product or production process will be identical within error measurements. Customer-oriented quality can be said to represent subjective quality because it can only be measured by the end user and can differ for the same product among users.

All these types of food quality are interconnected in some way. Thus, user-centered quality is affected by all three types of objective quality. However, these relationships do not always have to be clear and strong, because customer-oriented quality can be influenced by factors other than the characteristics of the product itself, such as the purchasing environment, point of sale, price, brand, etc. Much of the discussion about quality the food industry deals with quality and quality control oriented to products and processes, while the consumer evaluates and pays for subjectively perceived quality. The amount a consumer is willing to pay for a product depends on this subjectively perceived quality which is related to objective quality but is not the same. Improvements in objective quality, which do not affect the perception of consumer quality, will not have a commercial effect, and thus no positive effect on the competitive situation of producers[13].

5.2.2 Consumer assessment of food quality

Although there have been many approaches to the analysis of subjective quality in the social sciences, its multidimensional and hierarchical approach can be distinguished[14].

Most approaches assume that the perception of quality is multidimensional, that is, that quality is perceived by combining a number of product dimensions or characteristics. Economic theory of product quality makes a big difference between consumer research and demand, its experience, and the credibility of a product. Search characteristics, such as egg size or meat color, can be determined before purchase. In contrast, experience as an organoleptic perception of an individual can be established only after the product has been consumed and experienced. Unlike the first two characteristics, the consumer cannot find out if it is credible before the purchase, but it actually takes time and experience for the consumer to establish its credibility even after the purchase. For example, how can the consumer really realize that a product is produced according to the principles of organic production? Does the weight of the package really correspond to the weight on the declaration, etc. Therefore, the manufacturer or his products are expected to respect and guarantee what the product declares, so the credibility of the product is the trust gained and developed on the relation producer-consumer. It can be said that today trust, ie the delivery of true values, is the foundation of a long-term relationship with the consumer.

In the process of explaining multidimensional subjective quality of food, ie other consumer products in general, it is usually interpreted by referring to so-called multi-attribute attitude models[15], where the overall evaluation of the product is explained in terms of its perceived characteristics, evaluation of these characteristics and integration rules. Perceived characteristics of a product may differ depending on the performance of its internal or external attributes[16]. Internal attributes refer to physical product attributes, while external attributes refer to elements such as brand, price, physical environment, services, people, etc. So what can be identified as a key issue for the consumer food quality evaluation process is why certain product characteristics contribute positively to the overall evaluation of the product while others do not.

Therefore, a product attribute is not relevant in itself, but only to the extent that the consumer expects the attribute to lead to one or more desirable or undesirable consequences[17]. On the other hand, the relevance and desirability of these consequences are determined by the consumer's personal values. The consumer is motivated to choose a product if it leaves the desired consequences, thus contributing to the achievement of personal values. Thus, the subjective perception of consumer products is established by associations between product attributes and more abstract, central cognitive categories such as values, which can motivate behavior and create interest in such a product. In the field of food production and sales, it is very important to link product attributes with the consequences of consumption that lead to higher levels of quality of life or personal satisfaction and happiness[18]. Thus, for example, the color of an individual fresh food product associates or may lead the consumer that such a product is fresh, healthy, real and full of flavor, ie the expected quality is delivered while satisfying certain intrinsic subjective motives of purchase. The established model of subjective perception of quality and delivery of demand is the fulfillment of basic consumer goals, which are to meet his wishes and needs[19], and is an important factor in understanding the subjective perception of product quality and is the main contribution to the model for overall food quality through analysis the process of perceiving the quality of food products.

5.3 Total food quality model

Consumer demand for adequate product and its assessment, consumer experience and product credibility are important elements in understanding the subjective perception of quality and are the main contributors to the model of overall food quality, ie the findings of the process of food quality perception. The Total Food Quality Model (TFQM) was developed by Grunert et al[6] and is based on the concept that food quality is divided into four groups (Figure 2).

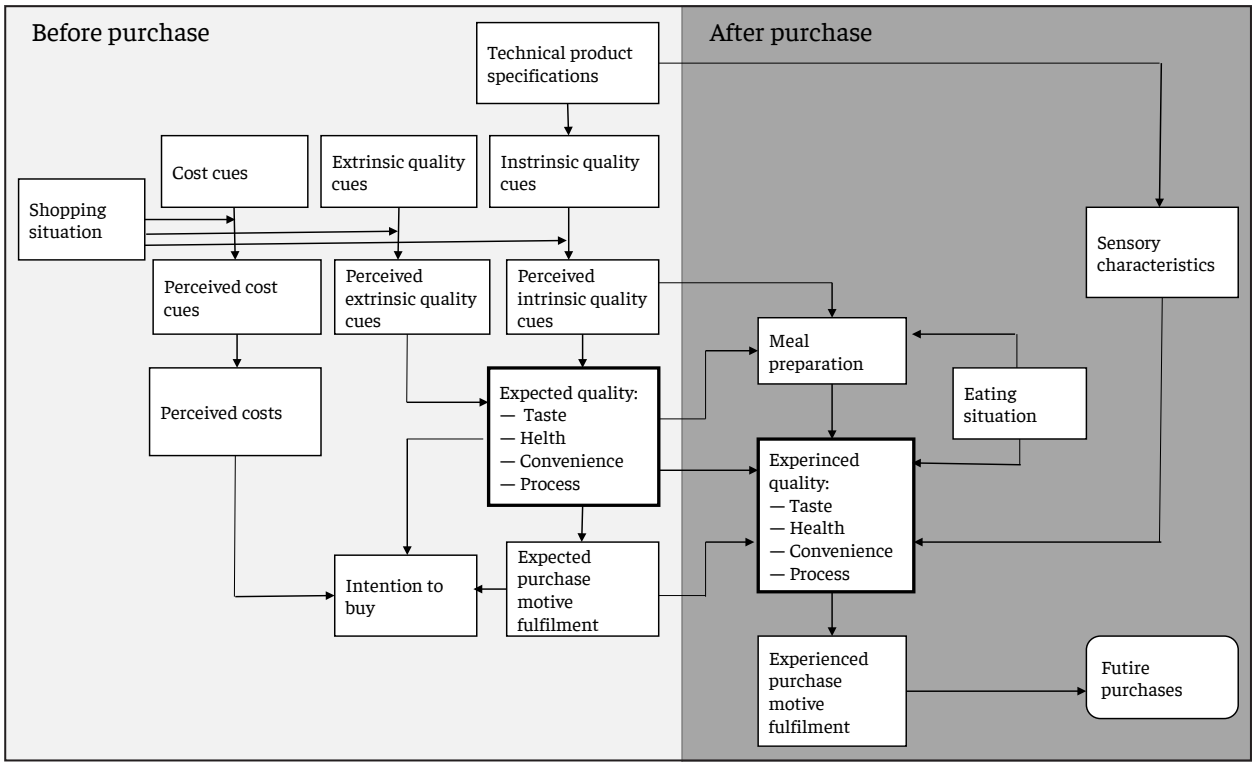

Figure 2. *Total food quality model (TFQM)*
Source: Grunert et al.[22]

The basis of the overall food quality model is the difference between the evaluation of food products before and after purchase. Most food products have the characteristics of its assessment and evaluation only to a limited extent. In order to make a choice, the consumer develops the domain of his own expected quality,

but only after consumption can the experienced quality be determined. The pre-purchase component of the model shows how quality expectations are formed based on available quality attributes. Attributes of internal quality are related to technical product specifications – that is, characteristics that can be measured objectively. External quality marks represent all other characteristics, such as brand name, price and packaging.

The way consumers use quality labels to realize expected quality can be quite complicated and, at first glance, sometimes seems quite irrational. For example, consumers use the color of fruit or fish to assess their freshness, the consistency of dairy products to define taste, or the shape or packaging of individual products to define sanitation.

Among the individual appearance characteristics of the products to which consumers are exposed, the influence on the definition of the expected quality is asigned to those who are actually perceived[20]. The emerging characteristics of the products to which consumers are exposed and to which they react influence purchasing decisions

According to the model of overall food quality, quality is not an end in itself, but is desirable because it helps to satisfy the motive or value of the purchase. The values sought by consumers, in turn, will have an impact on the search for quality dimensions, and on how different attributes and characteristics of products are perceived and valued. Expected quality and expected fulfillment of the motives of purchase represent the positive consequences that consumers expect from the purchase of a food product, and are compensated with negative consequences in the form of costs. Compromise determines the intention to buy. Price can be both an indicator of price and a sign of external quality. After the purchase, the consumer will have a quality experience that often deviates from the expected quality. Experienced quality is influenced by many factors: the product itself, especially its sensory characteristics, but also the way the product is prepared, situation factors such as meal type, consumer mood, previous experience, etc. Expectations themselves can also be an important variable in determining experienced product quality[21]. It is believed that the relationship between quality expectations and quality experience determines product satisfaction and thus the likelihood of repurchasing the product[22].

The total food quality model does not explicitly include price as an external attribute because it does not consider it as perceived value, but instead includes perceived quality and perceived costs.

5.3.1 Dimensions of quality

The model of total food quality looks at quality as a mental construct of consumers, and distinguishes between expected and perceived quality. In addition, it sees quality as an abstract construct, derived from information available in the consumer environment and his own experience, which are key to motivating to buy. Thus, food quality is a multidimensional phenomenon. In particular, from the consumer's point of view, food quality, expected and perceived, has four main dimensions: These dimensions appear to be taste and appearance, health dimension, functionality and process[23].

For most people, food has always been a matter of pleasure. Hedonistic characteristics of food, primarily taste, but also appearance and smell, represent a central dimension of quality for consumers. But in recent decades, consumers have shown increasing interest in other dimensions of quality. The hedonistic quality dimension mainly represents the experience characteristic of a food product, since the taste can usually be established only after consumption.

The health dimension of quality has become very important for many consumers, and numerous studies show that today health is just as important as taste, and that consumers form preferences based on this dimension motivated by expectations of longer life and higher quality life[24]. Health-oriented food quality is considered to be the way consumers perceive a food product and how it can affect their health. This includes functional food quality. Consumers are also concerned about safety and risk issues.

Complementary to food health issues, consumers are increasingly attaching importance to the way food is produced. Namely, the production process itself has become an object of consumer interest, and thus also a dimension of quality, even when there is no direct impact on the taste or health of the product. This quality dimension includes, for example, organic production, production that takes into account animal welfare

and GMO-free production. This dimension of quality is also a feature of credibility, as the consumer must rely entirely on guarantees of quality geared to production from different sources.

Finally, another factor is of growing importance for consumers, and that is the practicality and functionality of food. From a consumer point of view, convenience is much more than ease of purchase or quick consumption. Convenience means saving time, physical or mental energy in one or more phases of the entire meal process: planning and buying, storing and preparing products, consuming, and cleaning and disposing of leftovers.

The four dimensions of quality should not be viewed independently of each other, it can be seen that there are overlaps and interrelationships. These interrelationships are ambiguous and vary from product to product. For example, consumers sometimes feel that good taste and health are positively correlated, and at other times negatively correlated. Sometimes taste is considered to be related to the process quality dimension, and sometimes not. Such conclusions are typical of consumer quality perception.

5.3.2 Consumer segments

Although these dimensions of food quality are quite universal, their relative importance can vary significantly from consumer to consumer. In general, food selection processes and quality perceptions are characterized by individual differences, not only will there be differences in the relative importance of quality dimensions, but also in the way it is perceived from its individual characteristics, in the way consumers buy and thus become exposed to different types of food characteristics.

In order to take these differences into account, different segments of food consumers need to be distinguished. Consumers are categorized according to their different ways of buying, ways of preparing food, situations in which they consume food, ways of assessing qualitative dimensions and motives for buying food, or their food-related lifestyle[25].

Consumption and consumption of food is one of the fundamental motives for achieving the elements of quality of life. Consumer life, which is directly linked to the purchase and consumption of food, is also reflected in the establishment of food consumer segments[12]:

1. *Passive consumers of food* – for them food is not a central element in life. Consequently, their motives for buying food are weak, and their interest in food quality is limited mainly to the convenience aspect. They are also uninterested in most aspects of shopping, do not use specialty stores, and do not read product data, limiting their exposure and processing of food quality labels. Even their interest in the price is limited. They have little interest in cooking, tend not to plan meals and eat out. Compared to the average consumer, these consumers are free, young, have part-time or full-time jobs, average to low incomes and usually live in big cities.
2. *Carefree food consumers* – these consumers resemble the non-compulsory food consumer, in the sense that food is not very important to them, and, with the exception of practicality, their interest in food quality is extremely low. The main difference is that these consumers are interested in news, love new products and try to buy them spontaneously, at least if they do not require a lot of effort in the kitchen or new cooking skills. A carefree food consumer in general, like an unrestrained food consumer, is young and often lives in big cities. But unlike those who are not included, these consumers are more educated and are in the upper income classes.
3. *Conservative food consumers* – for these consumers, safety and stability achieved by following traditional feeding patterns are the main motive for buying. They are very interested in the taste and health aspects of food products, but they are not particularly interested in comfort because meals are prepared in the traditional way and are considered part of women's tasks. Conservative food consumers have the highest average age and are the least educated. Households are smaller on average, and household income is generally lower than the income of other segments. These consumers usually live in rural areas.
4. *Rational food consumers* – these consumers collect and evaluate a lot of information when shopping, look at product data and prices, and use shopping lists to plan their purchases. They are interested in all aspects of food quality. Self-fulfillment, recognition and security are the main motives for buying

for these consumers, and their meals are usually planned. Compared to the average food consumer, this segment has a higher share of women with families. The level of education and income in this segment varies from country to country, but they usually live in medium-sized cities, and a relatively large proportion of these consumers do not work.

5. *Adventurous food consumers* – although these consumers have a slightly above-average interest in most aspects of quality, this segment is mainly characterized by the effort they put into preparing meals. They are very interested in cooking, looking for new recipes and new ways of cooking, involving the whole family in the cooking process, not interested in convenience and rejecting the opinion that cooking is a female task. They want quality and are looking for good taste in their food products. Self-fulfillment with food is an important motive for buying. Food and food products are important elements in the lives of these consumers. Cooking is a creative and social process for the whole family. The adventurous food consumer is generally from the younger part of the population, and the household size is above average. Adventurous food consumers have the highest level of education and high incomes. They tend to live in big cities.

It should be noted that the types described above are the basic segments of food consumers. In addition to these, there may be idiosyncratic segments that differ slightly from the basic types described above. But the fact is that taste and health are very important dimensions of quality, both in all countries and among segments.

5.4 Risk perception in terms of food consumption

Food is an important component for the development of the human body and the maintenance of life, and the promotion of health and the prevention of disease through a healthy diet are increasingly recognized as crucial in the modern world. The act of eating also has a strong social connotation, closely related to family unity, religious festivals and various forms of integration[26]. It is generally accepted that food produced and placed on the market today is safer than in the past, there are still possible situations when this safety is called into question, which can undermine consumer confidence and endanger their health. In addition to scientific information, knowledge of how consumers perceive the different risks they are exposed to in their diet and how it affects their consumption decisions is important for shaping food safety strategies, both for food business operators and the public sector, which is directly responsible and oversees the issue of general health security of the population.

The cognitive mechanisms of an individual condition the perception of food-related risk. They may differ from the risk of non-food products, essentially because food is a vital necessity and part of people's daily lives[26]. Some determinants seem to be particularly important in shaping people's reactions to food risk. For example, food of technological origin is perceived as more dangerous than natural food. An additional complication arises from acute versus chronic risk. For example, presenting a naturally occurring risk in an acute or crisis context (such as poisoning) may worsen the perception of risk. Figure 3 shows three dimensions of risk perception, natural and technological, controlled and uncontrolled, and new / unknown, or old / known risk[27]:

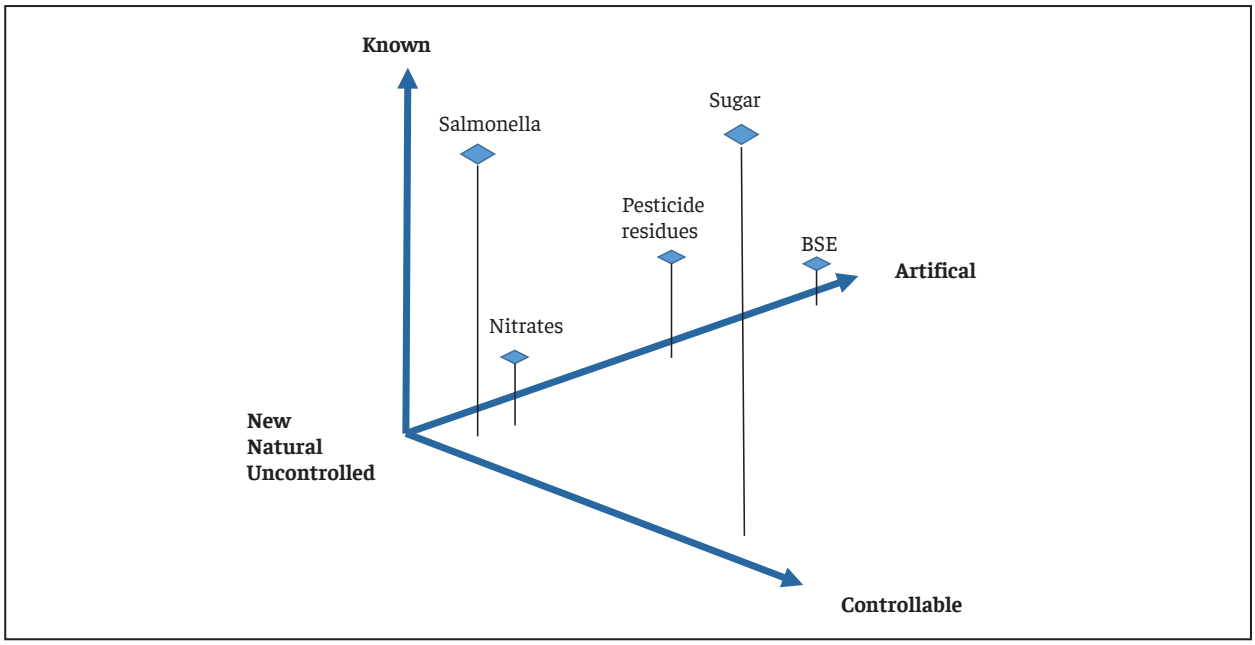

Figure 3. *Three dimensions of risk perception with food*
Source: Breakwell (2000)

For example, it can be concluded that sugar is in a high position on the axis of knowledge and risk control and is also recognized as a natural substance. However, pesticides have a low to moderate level of cognition, no control and are perceived more as technological / artificial than natural risks.

Gender, ethnicity, age and geographical area may be potential sources of variation in risk perception[27].

In the 2019 Eurobarometer[28], respondents mentioned the presence of antibiotics, hormones and pesticides in food as worrying food safety risk factors. Respondents also point to a personal interest in food safety, with a large number showing a high level of food safety awareness. Residents of the European Union are showing a kind of concern because they are of the opinion that food products are full of harmful substances. They are particularly critical of dyes, preservatives and additives, but also of antibiotic, hormone or steroid residues in meat, as well as the presence of pesticides in food (Figure 4).

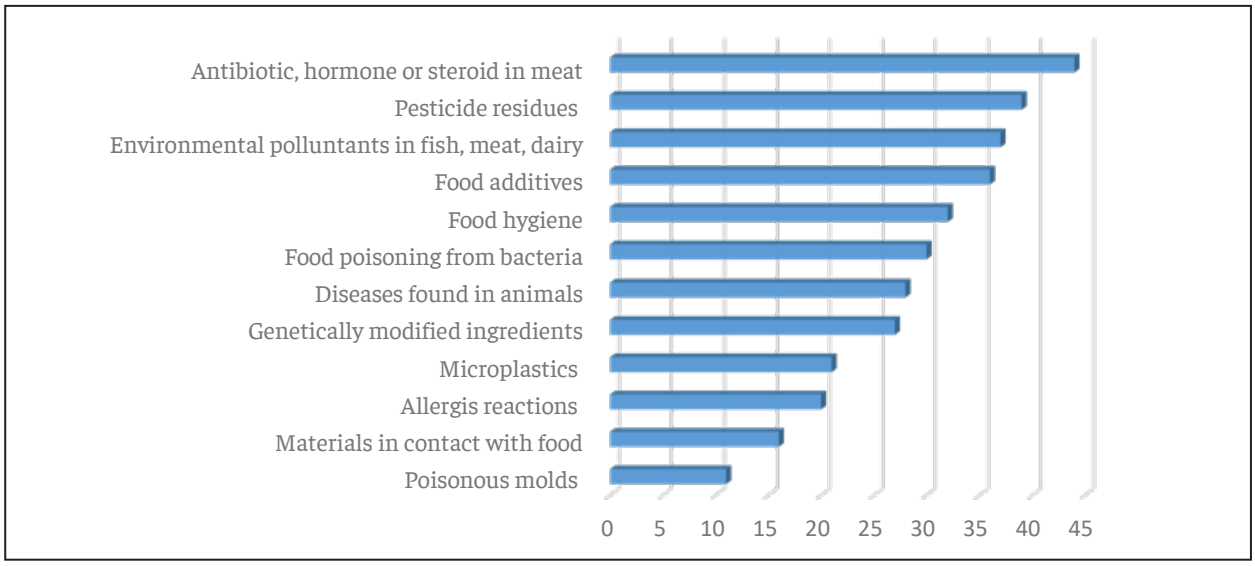

Figure 4. *Main topics related to food which worry Europeans*
Source: European Commission, 2019

It can be concluded that the perception of risk associated with food consumption is multifactorial and highly complex, which depends less on objective and roughly measurable risks than on subjective issues.

These issues encompass social, cultural, psychological, ethical, and moral aspects, which together make up what are called values or worldviews. More than rational and decisions based on technical-scientific knowledge, the emotional and intuitive side of individuals strongly contributes to the perception of food risks and their balance in relation to the realized benefits. In this sense, risk communication strategies aimed at filling gaps in scientific knowledge are usually ineffective if they are not aligned with approaches that consider and respect the human dimension that permeates the universe of perceptions.

5.5 Risk and benefit associated with food production

Food supply is generally considered healthy, nutritious and safe. However, a modern industrial food system can result in unwanted or unexpected outcomes that pose a threat to consumer health. Specific risks for consumers are microbial pathogens in food, so food-borne diseases can develop secondary diseases or complications such as arthritis after some salmonella infections. Pesticide residues and other chemical residues can remain on fruits and vegetables, and prolonged exposure to such chemicals in the diet can pose a risk of cancer or other adverse health effects. News of foodborne illnesses spreads easily and quickly, contributing to growing public concern about the problem. Therefore, the task is to provide a legal framework that can maximize the net benefits of increasing food safety, ie equating the marginal benefits of safer food with the marginal costs of achieving food safety objectives.

5.5.1 Consumer risk perception

In the area of food production, consumer responses appear to be dependent on perceptions of the risks and benefits associated with specific applications. The higher the perceived risk associated with a particular food production technology or associated hazards, the less favorable consumer attitudes[29]. Consumer attitudes towards food production technology include not only assessments of potential personal benefits and health effects, but also take into account moral attitudes and beliefs, such as ethical and moral considerations, and values such as concern for the integrity of nature[30]. The public perception that institutions and industries are forcing the introduction of genetically modified food to protect their own interests, rather than to support social welfare, has not alleviated social problems at all. In the future, new technologies applied in food production or convergence between different technologies in the agri-food sector (eg information and communication technologies, biotechnology, cognitive sciences and nanotechnologies) may raise other public concerns in conditions of increased complexity and uncertainty regarding and risks and benefits associated with food production processes and food products produced by those processes[31].

There is some evidence that the perceived risks and benefits associated with different food production activities or technologies are negatively related. That is, high levels of perceived risk are associated with low levels of perceived benefit, and vice versa. However, in the real world, high levels of risk have been found to be acceptable only when they are offset by high perceptions of the level of benefits[32]. Several theories have been developed and tested to explain the negative relationship between perceived risk and benefit. It is assumed that consumers' perceptions of risk and benefits depend on consumer confidence in institutions and industry. For example, when trust in scientists, government, and industry was controlled in the analysis, the inverse relationship between perceived risk and perceived benefit associated with different hazards decreased. Although it has been suggested that perceived risk is reduced when public knowledge, regulators and risk managers are trusted to control risks, other studies have shown that other dimensions of trust, such as caring for the public well-being of different actors, could outweigh perception. and risk attitudes. In addition, previous attitudes toward hazards or food production technologies may affect who the public trusts or dislikes. For example, if people have a strong attitude about a potentially dangerous activity, such as genetic modification of food products, they are more likely to trust the source sending the message according to their attitude, and they will not trust the source that provides the discrepancy. This means that trust does not necessarily affect risk perception and technology acceptance, but that overall attitudes can also guide more specific risk and trust perceptions. In close connection with this, affective responses to

danger or emotions caused by a certain topic of danger lead to the perception of risks and benefits. Affective responses to an event or object can serve as a mental shortcut in assessing risks and benefits. Using influence in the processing of cognitive information could be more efficient in terms of allocation of mental resources and easier to use compared to analytical reasoning about benefits and risks, and could be particularly useful when mental resources are limited. It has been empirically proven that the impact comes first and affects risk and benefit assessments[33]. Thus, in conditions of time pressure, evaluations of low-risk, high-benefit activities and technologies were more frequent, compared to conditions in which no time constraints were applied. When individuals can obtain adequate information about the degree of risk or benefit, it can have a beneficial effect on later risk and benefit assessments. That is, information indicating a high benefit increases subsequent benefit assessments, but also reduces the perception of risk associated with the activity or technology of food production under consideration. Risks and benefits are not assessed independently of each other, these consumers make affectively matched risk and benefit assessments. The tendency for the overall affect to serve as a sign of judgment is also called the heuristic of affect[34]. Namely, alternative perception of risk can be understood as a type of feeling that includes worries, fear or anxiety as agents of risk situations.

Furthermore, perceived risk and benefit may be inversely related, as consumers have a need for consistency in beliefs, and as such seek to avoid cognitive dissonance or conflict between different beliefs. Thus, it is cognitively difficult for consumers to perceive the great risks and great benefits associated with the same dangers at the same time. Finally, the inverse relationship between risk-benefit assessments could be explained to consumers who make judgments about "net risk" and "net benefit" because they do not assess risks and benefits independently of each other[35]. This means that when the net risk is high, the net benefit is low, and vice versa.

5.5.2 Food safety risk communication

Effective communication on the risks and benefits of food is important from the perspective of optimizing consumer protection associated with food consumption[36], and increasing social confidence in those institutions responsible for assessing and managing (perceived) risks in food. The need for effective risk communication could arise from the application of specific agricultural practices or food processing technologies that may raise societal concerns, such as genetic modification of crops and animal husbandry. Alternatively, the need for effective communication with the public may arise due to chemical, microbiological or physical contamination of food. In addition, communication may be needed as a result of a food crisis following an incident in the food supply chain or after the identification of new scientific knowledge about specific risks in food.

In addition to the impact on human health, communication may also focus on the potential environmental impacts of food production and the risk mitigation or management measures applied to mitigate the risk[37]. In addition, risk communication is important in relation to various socio-economic impacts, for example, on employment, food costs, livelihoods in rural areas or cultural structures and institutional relationships. Examples of different types of food safety issues, which are classified according to whether they were intentionally or accidentally introduced into the food chain or occur naturally.

Various factors can be identified that may influence the determination of the effectiveness of risk communication, whether it is designed to reduce consumer risk behavior or as a basis for informed choices regarding food consumption decisions. Food consumer risk perceptions should be taken into account when developing an effective risk communication strategy, including whether a potential hazard is considered artificial or natural. or was accidentally or intentionally introduced into the food chain. Whether the risk is presented in an "acute" or "chronic" context is also relevant when considering the communication process. Consumer confidence in the information provided, as well as the established regulatory framework for protection and transparency of decisions can also be influential and should be included in the development of effective information, where relevant. Communication on uncertainty about the risks and benefits of scientific assessment may also be relevant and needs to be disseminated in terms of consumer protection or building consumer confidence.

Therefore, an important question in the field of food risk communication is whether different approaches with greater or lesser degree of success have been applied for different types of potential hazards and whether the time frame affects the success of communication.

5.6 Observed quality and safety related to readiness to purchase

The importance of any marketing strategy lies in achieving the quality of the product or service, or the benefits that are delivered to consumers. Quality can be understood as all those products and services that meet the explicit and implicit needs of consumers[38]. Through the development and maturation of the marketing paradigm and through its application, the foundation of quality policy was product control before reaching consumers.

The goal of current marketing policies is to translate the perception of consumer food quality into objective parameters, product attributes, and through the development of new improved food products. Studying the perception of consumer food quality is one of the most complex areas in researching consumer behavior. As a consequence of any food crisis, consumers feel greater concerns about food quality and safety, seeking greater transparency in the food chain and more information on the different quality characteristics of food. Understanding consumer perceptions, attitudes and behaviors regarding food is of great importance. Knowledge, knowledge and information about nutrition and health are the cognitive and affective precursors of consumer attitudes, perceptions and beliefs.

Today, food as a product can provide benefits that are hedonistic or utilitarian in nature[39]. Hedonistic products enable more experiential consumption by provoking fun, pleasure, excitement, happiness, imagination or enjoyment, while utilitarian products are primarily instrumental, functional, goal-oriented and associated with self-control[40]. Hedonistic attributes or values are important for food selection in general.

Consumer behavior when buying food has changed significantly around the world. Increased health awareness and a changing lifestyle, along with growing concerns about the benefits of food for a healthy and stable life, have led to significant changes in consumer behavior towards food consumption. Consumers are becoming increasingly aware of the importance of food safety and its impact on their health. Moreover, consumers are also increasingly clinging to the country of origin of food in their purchasing decisions. The choice of food consumers is influenced by various factors related to demography, psychography and product and market offerings. With increasing awareness of the health and properties of food products, it becomes important to understand whether consumers are willing to pay the extra amount of money to buy the right food products

Willingness to pay is the highest price a consumer is willing to pay for a product or service. Willingness to pay can vary significantly from consumer to consumer. Willingness to pay is determined by external or internal motives for payment. Motives are easily identifiable and are usually those factors that can generally be detected such as age, gender, income, education and place of residence[41].

Internal motives, on the other hand, represent the characteristics of the individual. They are difficult to spot and are often referred to as “imperceptible differences”. An individual’s risk tolerance, desire to fit in with others, and level of passion for a particular topic are examples of intrinsic motivations that can affect their willingness to pay.

When a consumer has an urgent need, he may be willing to pay a higher price than when his needs are less urgent. Similarly, an actual or perceived shortage of supply could make them more willing to pay a higher price than when there is a surplus. On the other hand, the willingness of consumers to pay may be lacking due to the emergence of a new competitor with a stronger brand recognition or perception that the product or service is outdated.

By determining consumers’ willingness to pay, food companies can set their prices to a level that allows them to maximize profits and consumer satisfaction.[42]

Bibliography

[1] Fernqvist, F., Ekelund, L. (2014) Credence and the effect on consumer liking of food – A review. Food Quality and Preference, 32, 340–353. https://doi.org/10.1016/j.foodqual.2013.10.005

[2] Kaczorowska, J., Prandota, A., Rejman, K., Halicka E. (2021) Certification Labels in Shaping Perception of Food Quality – Insights from Polish and Belgian Urban Consumers. Sustainability, 13(2), 702. https://doi.org/10.3390/su13020702

[3] Sadilek, T. (2019) Perception of Food Quality by Consumers: Literature Review. European Research Studies Journal, 22(1), 52–62. https://doi.org/10.35808/ersj/1407

[4] López Davis, S., Marín Rives, L., Ruiz de Maya, S. (2017) Introducing Personal Social Responsibility as a key element to upgrade CSR. Spanish Journal of Marketing – ESIC, 21(2), 146–163. https://doi.org/10.1016/j.sjme.2017.04.001

[5] Petrescu, D. C., Vermeir, I., Petrescu-Mag, R. M (2020) Consumer Understanding of Food. International journal of environmental research and public health, 17(1), https://doi.org/10.1016/j.foodcont.2012.01.038

[6] Grunert, K. G., Larsen, H. H., Madsen, T. M., Allan Baadsgaard, A. (1995) Market Orientation in Food and Agriculture. Dordecht. Kluwer Academic Publisher.

[7] Blazquez-Resino, J. J., Gutierrez-Broncano, S., Jimenez-Estevez, P., Perez-Jimenez, I. R. (2021) The Effect of Ethnocentrism on Product Evaluation and Purchase Intention: The Case of Extra Virgin Olive Oil (EVOO). Sustainability, 13, 4744. https://doi.org/10.3390/su13094744

[8] Chambers, S., Lobb, A., Butler, L., Harvey, K., Traill W. B. (2007) Local, national and imported foods: a qualitative study. Appetite, 49(1), 208–13. https://doi.org/10.1016/j.appet.2007.02.003

[9] Lusk, J., Brown, J. P., Mark, T. B., Proseku I. (2006) Consumer Behavior, Public Policy, and Country-of-Origin Labeling. Review of Agricultural Economics, 28(2), 284–292. https://doi.org/10.2307/3700760

[10] Ma, Q., Abdeljelil H. M., Hu, L. (2019) The Influence of the Consumer Ethnocentrism and Cultural Familiarity on Brand Preference: Evidence of Event-Related Potential (ERP). Frontiers in Human Neuroscience, 13, 220. https://doi.org/10.3389/fnhum.2019.00220

[11] Guo, G., Zhou, X. (2017) Consumer ethnocentrism on product judgment and willingness to buy: A meta-analysis. Social Behavior and Personality: an international journal. 45. 163–176. https://doi.org/10.2224/sbp.5548

[12] Brunsø, K., Fjord, T. A., Grunert, K. G. (2002) Consumers' food choice and quality perception. Aarhus: Aarhus School of Business, MAPP working paper no. 77.

[13] Garrido-Morgado, Á., González-Benito, Ó., Martos-Partal, M. (2016) Influence of Customer Quality Perception on the Effectiveness of Commercial Stimuli for Electronic Products. Frontiers in psychology, 7, 336. https://doi.org/10.3389/fpsyg.2016.00336

[14] Jomaa, L. H., Hwalla, N. C., Zidek, J. M. (2016) Development of a standardized measure to assess food quality: a proof of concept. Nutrition Journal, 15(96), 2–11. https://doi.org/10.1186/s12937-016-0215-4

[15] Fishbein, M., Ajzen, I. (1980) Predicting and understanding consumer behavior: Attitude-behavior correspondence. In Ajzen, I., Fishbein, M. (eds.). Understanding Attitudes and Predicting Social Behavior (pp. 148–172). Englewood Cliffs, NJ: Prentice Hall.

[16] Stylidis, K., Wickman, C., Söderberg, R. (2020) Perceived quality of products: a framework and attributes ranking method, Journal of Engineering Design, 31(1), 37–67. https://doi.org/10.1080/09544828.2019.1669769

[17] Grzybowska-Brzezińska, M., Kuberska, D., Ankiel, M., Brelik A. (2020) Consumer's Behavior in a Multi-Attribute Concept of a Food Product. European Research Studies Journal, 23(1), 526–551. https://doi.org/10.35808/ersj/1570

[18] Zhong, Y., Moon, H. C. (2020) What Drives Customer Satisfaction, Loyalty, and Happiness in Fast-Food Restaurants in China? Perceived Price, Service Quality, Food Quality, Physical Environment Quality, and the Moderating Role of Gender. Foods, 9, 460. https://doi.org/10.3390/foods9040460

[19] Espejel, J., Fandos, C., Flavian, C. (2007) The role of intrinsic and extrinsic quality attributes on consumer behaviour for traditional food products Journal of Service Theory and Practice, 17(6), 681–701. https://doi.org/10.1108/09604520710835000

[20] Spence, C. (2015) On the psychological impact of food colour. Flavour, 4(21), 2–16. doi: https://doi.org/10.1186/s13411-015-0031-3

[21] Popovic, I., Bossink, B. A. G., van der Sijde, P. C. (2019) Factors Influencing Consumers' Decision to Purchase Food in Environmentally Friendly Packaging: What Do We Know and Where Do We Go from Here?. Sustainability, 11, 7197. https://doi.org/10.3390/su11247197

[22] Grunert, K. G., Bredahl, L., Brunsø, K. (2004). Consumer perception of meat quality and implications for product development in the meat sector—a review. Meat Science, 66(2), 259–272. https://doi.org/10.1016/S0309-1740(03)00130-X

[23] Grunert, K. G., Larsen, H. H., Madsen, T. K., Baadsgaard, A. (1996) Market Orientation in Food and Agriculture. Boston, MA: Kluwer

[24] Topolska, K., Florkiewicz, A., Filipiak-Florkiewicz, A. (2021) Functional Food-Consumer Motivations and Expectations. International journal of environmental research and public health, 18(10), 5327. https://doi.org/10.3390/ijerph18105327

[25] Funk, A., Sütterlin, B., Siegrist, M. (2020) Consumer Segmentation based on stated Environmentally-friendly Behavior in the Food Domain. Sustainable Production and Consumption, 25(5), https://doi.org/10.1016/j.spc.2020.08.010

[26] Kaptan, G., Fischer, A. R. H., Frewer, L. J. (2018) Extrapolating understanding of food risk perceptions to emerging food safety cases. Journal of Risk Research, 21(8), 996–1018. http://dx.doi.org/10.1080/13669877.2017.1281330

[27] Breakwell, G. (2000) Risk communication: factors affecting impact. British Medical Bulletin, 56(1), 110–120. http://dx.doi.org/10.1258/0007142001902824 PMid:10885109

[28] European Commission (2019) Special Eurobarometer Wave EB91.3: food safety in the EU Brussels: TNS Opinion & Social. Retrieved from https://www.efsa.europa.eu/sites/default/files/corporate_publications/files/Eurobarometer2019_Food-safety-in-the-EU_Full-report.pdf

[29] Tucker, M., Whaley, S., Sharp, J. (2006) Consumer perceptions of food-related risks. International Journal of Food Science & Technology. 41(2), 135–146. https://doi.org/10.1111/j.1365-2621.2005.01010.x

[30] Iaccarino, M. (2001) Science and ethics. As research and technology are changing society and the way we live, scientists can no longer claim that science is neutral but must consider the ethical and social aspects of their work. EMBO reports, 2(9), 747–750. https://doi.org/10.1093/embo-reports/kve191

[31] Renn, O., Roco, M. (2006) Nanotechnology and the need for risk governance. Journal of Nanoparticle Research 8(2), 153–191. https://doi.org/10.1007/s11051-006-9092-7

[32] Ferrer, R., Klein, W. M. (2015) Risk perceptions and health behavior. Current opinion in psychology, 5, 85–89. https://doi.org/10.1016/j.copsyc.2015.03.012
[33] Labott, S. M., Johnson, T. P., Fendrich, M., Feeny, N. C. (2013) Emotional risks to respondents in survey research. Journal of empirical research on human research ethic : JERHRE, 8(4), 53–66. https://doi.org/10.1525/jer.2013.8.4.53
[34] Schirrmeister, E., Göhring, A.-L., Philine Warnke, P. (2020) Psychological biases and heuristics in the context of foresight and scenario processes. Future & Foresight Science, 2(2), 1–18. https://doi.org/10.1002/ffo2.31
[35] Ponce R., Bartell, S. (2000) Use of Quality-Adjusted Life Year Weights with Dose-Response Models for Public Health Decisions: A Case Study of the Risks and Benefits of Fish Consumption. Risk Analysis, 20(4), 529–542. https://doi.org/10.1111/0272-4332.204050
[36] Frewer, L. I., Fischer, A. R. H. Brennan, M., Bánáti, D., Lion, R., Meertens, R. M., Rowe, G., Siegrist, M., Verbeke, W., Vereijken, C. M. J. L. (2016) Risk/Benefit Communication about Food—A Systematic Review of the Literature, Critical Reviews in Food Science and Nutrition, 56(10), 1728–1745. https://doi.org/10.1080/10408398.2013.801337
[37] Dosman, D. M., Adamowicz, W. L., Hrudey, S. E. (2001) Socioeconomic determinants of health-and food safety-related risk perceptions. Risk Anal. 21(2), 307–317. https://doi.org/10.1111/0272-4332.212113
[38] Espejel, J., Fandos Herrera, C., Flavian, C. (2007) The role of intrinsic and extrinsic quality attributes on consumer behaviour for traditional food products. Journal of Service. Theory and Practice, 17(6), 681–701. https://doi.org/10.1108/09604520710835000
[39] Prugsamatz, S., Pentecost, R. D., LOfstad, L. (2006) The influence of explicit and implicit service promises on Chinese students' expectations of overseas universities. Asia Pacific Journal of Marketing and Logistics, 18(2), 129–145. https://doi.org/10.1108/13555850610658273
[40] Olsen, J., Thach, L., Hemphill, L. (2012) The impact of environmental protection and hedonistic values on organic wine purchases in the US. International Journal of Wine Business Research, 24(1), 47–67. https://doi.org/10.1108/17511061211213783
[41] Liao, Y. (2021) The Sources and Influencing Factors of Hedonistic Consumption. Psychology, 12(4), 660–674. https://doi.org/10.4236/psych.2021.124041
[42] Kamboj, S., Matharu, M. (2021) Modelling the predictors of consumers' willingness to pay premium price for sustainable products. Journal of Asia Business Studies, 15(4), 559–583. https://doi.org/10.1108/JABS-03-2020-0099

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CHAPTER 6

Quality assurance in agri-food chains

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6.1 Introduction

As already mentioned, food quality is not easy to define and there is no single definition of food quality, which would be comprehensive and contain all the elements of the definition.[1] Therefore, food quality is assessed on the basis of attributes or properties of food quality in each agri-food chain. In general, quality consists of eight basic dimensions[1], which are:

1. execution
2. features (attributes)
3. reliability
4. compliance
5. durability
6. possibility of servicing
7. aesthetics
8. proven quality.[2]

Of course, the 6th dimension of quality, *'serviceability'*, is not applicable to the quality of food, *ie food products*, so it is replaced in the agri-food chain by *traceability*[2] and *improvements* (cf. Chapter 6.2). However, every performance of a food product must be flawless. Namely, the case of any poor performance of a food product can endanger the health of consumers.[3] *Features or attributes* of food quality are discussed in detail in ch. 4. *The reliability* of any food product is the result of its good performance and it is a consequence of *good external and internal attributes of quality* and its performance. *Conformity* of food products unlike other products implies compliance with the nutritional needs and expectations of consumers (both in nutritional and safety terms), but also compliance with the standards prescribed by food legislation. *The durability* of food products is an extremely important property of quality. This primarily means the shelf life under appropriate storage conditions. *The aesthetics* of each product is extremely important for the visual perception

[1] *cf.* ch. 4. Attributes of food quality and sources of danger in agri-food chains.
[2] *cf.* ch. 1. Agricultural food chains → 1.6. Traceability in the agri-food chain
[3] *cf.* ch. 4.3. Sources of danger in agri-food chains

of consumers. However, when it comes to food products, aesthetic qualities are manifested at the level of packaging design and at the level of food product appearance. The notion of *proven quality* of a food product appears on three levels. At the level of actual evidence the declaration of the product with the specified control body or accredited laboratory that conducted the appropriate analyzes should be stated, at the level of clearly visible markings on the packaging of the food product on the quality control system (eg HACCP, Halal, Kosher, GGN) and personal perceptions of consumers who identify the quality of a product with its geographical origin (eg Croatian quality brand, or Italian pasta or wines with a certain geographical origin, etc.). Often even the very name of a manufacturer's company is identified by consumers of a particular food product with the quality of that product.

In any case, in order for the quality of an agricultural and/or food product to be manifested in all eight dimensions of quality[1, 2], it is necessary to design and implement the most appropriate and efficient quality assurance and management system in the entire agri-food chain.

6.2. Differences between managerial and technological approach in quality management in agri-food chains

Food quality management includes food quality with all its properties or quality attributes and overall quality management[3]. In order to achieve the most efficient food quality management in any agri-food chain, it is necessary to establish a food quality management system according to a methodology that combines technological and managerial approach to quality management[4]. The basic engine of any quality assurance and management process in any industry is the *b* or *PDCA cycle*[5]. It is known that the PDCA cycle or Deming quality cycle consists of four phases that continue on top of each other and never end, at least not as long as there is a specific organization and/or specific product/production. These phases are known as: Plan – Do – Check – Act.

In particular, the *planning phase – for technologists* – involves the design of a particular food product, its safety for consumer health, nutritional value and sensory properties and the organization of its production. *For management,* the planning phase means increasing sales, increasing cost efficiency, increasing profits. Sometimes the views of technologists and company managers are conflicting. For example, if in the opinion of technologists certain changes need to be introduced in the technological process, which certainly requires investment, and the key indicator of business efficiency of management is cost efficiency (known as 'cost cutting'), then there is inevitably a conflict between the two sides in the project team. Therefore, it is necessary to answer three basic questions before starting the PDCA cycle:

1. What improvements are needed?
2. What changes are needed to make improvements?
3. What are the measurable indicators to determine that the implemented changes have led to improvement?

Only when the members of the quality assurance and management team agree on their answers to these three questions can an appropriate decision be made to plan certain changes regardless of their nature, whether it is designing a new product or investing in irder to reduce losses and generate savings in the production process[6], or about any other change that is supposed to lead to the necessary improvements.

The question arises; – How is it possible that in an organization dedicated to food production there may be differences in defining priorities in determining the necessary improvements and changes in the process that lead to them?

The answer is; – Because there are groups that have different approaches to economics, which is often conditioned by differences in worldview.

Namely, according to one definition, economics is the science and skill of how to use scarce resources (money, but also natural and human resources) to produce and distribute new goods and services that will meet the needs of those for whom they are intended and those who create them[7]. However, there are generally two different approaches in economics, namely normative economics and positive economics[8]. Norma-

tive economics aims to determine what should happen or what should happen. It is often determined by worldview (and even ideological) attitudes, and unfortunately sometimes by prejudice. Positive economics, on the other hand, relies on facts, that is, on what is happening.

It should be noted that supporters of both normative and positive economics are represented both among technologists and in management. This is very well illustrated by the two most common statements that can very often be heard in a conversation:

1. "We can produce anything we want, there are essentially no technological limitations."
2. "They want everything to be over yesterday, and they never provide the necessary budget for the necessary investments."

The first statement is typical for managers who will focus their improvement measures on changing the organizational structure, developing procedures, improving the level of knowledge through various workshops, trainings, consultations and removing responsible persons from certain positions (although there are no real reasons), etc.

The second statement is characteristic of technologists who will propose the purchase of new machines, improvements in the technological process, the introduction of more sophisticated analyzes, educating employees about biochemical processes, etc.

That is why it is extremely important to integrate these two opposing attitudes into the techno-managerial approach[9].

In quality assurance in the agri-food chain, the techno-managerial approach includes:

- Knowledge of hazards; biological, chemical and physical.
- Sampling and analysis; raw materials, semi-finished products, finished products, products in stock and on shelves, as well as market research, ie target groups of consumers and competition.
- Knowledge of changes in food properties in the agri-food chain; in primary production, post-harvest storage, processing, food storage, distribution.
- Decision making; based on the analysis and synthesis of data collected under the previously listed points.
- Evaluation and confirmation of the efficiency of the quality assurance and management system, including safety management from the aspect of hygienic and health safety of food products[10].
- Development of quality culture; that is, an adequate model of *quality behavior* that will unite all the elements listed under the previous points.

Everything needed to achieve a techno-managerial approach to quality assurance in the agri-food chain is contained in *fourteen Deming*[4] *points*[11, 12, 13]:

1. Create a statement to all employees of the goals and purposes of the company or other organization. Management must constantly demonstrate its commitment to this statement through its actions and behavior.
2. Adopt a new philosophy, from top management to each employee.
3. Understand that the purpose of inspection (syn. Verification) is to improve the process and reduce costs.
4. Abandon the practice of awarding jobs only on the basis of price.
5. Constantly and always improve the system of production and services.
6. Institutional training.
7. Teach and establish leadership.
8. Remove fear. Establish trust. Establish an innovation climate.
9. Optimize the efforts of teams and groups according to the goals and purpose of the company.
10. Remove constant reprimands in the workplace.

[4] Dr. W. Edwards Deming (1900-1993) was a professor at the Massachusetts Institute of Technology (MIT). He developed a number of sampling techniques to improve labor statistics. He was a world-renowned management and quality consultant. United States President Ronald Reagan awarded him the 1987 National Medal of Technology and Innovation.

11. a) Abandon production quotas and learn and introduce methods of improvement instead
12. b) Leave M.B.O.[5] instead develop employees' knowledge of processes and how to improve them.
13. Remove barriers that take away people's pride in making.
14. Encourage education and personal development for everyone.
15. Take action to bring about transformation.

The main tools applied in the techno-managerial approach to quality assurance in the agri-food chain are *communication, analytics and statistics.*

6.3 Steps of the risk management process in the agri-food chain

When we talk about risk management in the agri-food chain (s), we mean *the risks related to the hygienic and health safety of agricultural and food products* for human and animal health. Therefore, risk management in agri-food chains refers exclusively to the assessment, monitoring and control of chemical, physical and biological hazards in agri-food chains.[6]

The first, ultimate and basic step in risk management in agri-food chains is RISK ASSESSMENT(!). The second step is RISK MANAGEMENT.

6.3.1 Risk evaluation

Risk assessment in the agri-food chain also has its epidemiological significance[14]. Namely, epidemiology is not only focused on disease research, but it is a holistic science in which economics, management, natural sciences and sociology are united in a common field of *public health*. So it should come as no surprise that a large number of acute, but also chronic, diseases are associated with the consumption of certain foods.[7] Numerous food allergies are known[15], but also chronic food poisonings that cause genotoxicity and lead not only to the appearance of carcinogenic diseases, but also to deformities in the offspring[16, 17]. However, how can we conduct a risk analysis of any of the harmful agents in the agri-food chain or some other factor that may affect some other properties of food quality?

Risk assessment is performed through the following stages:

Phase I
Draw a flow diagram of the agri-food chain for a particular product. Only by knowing all the details of production, procurement, logistics and distribution is it possible to assess the possibility of the risk of contamination by some of the harmful agents. Moreover, an accurate process flow diagram allows the detection and causes of errors in production, distribution and transport that have led to spoilage or reduction in the quality of a food product. *Therefore, the flow diagram of all processes, in each agri-food chain, must be clear and accurate(!).*

Phase II
After making a detailed flow chart of the process, and if possible, in parallel with its development, make a *decision tree.* However, in practice, many times (unfortunately even *too often*) the decision tree is made in a template, ie without taking into account the details of the flow diagram of the process in the agricultural production chain. Namely, the decision tree method was developed in the United States in the mid-1960s[18]

[5] M.B.O. Management by Objectives - Management by Objectives is a strategic management model that aims to improve organizational performance by clearly defining objectives that both management and employees agree on. Critics of the MBO argue that this leads employees to try to achieve their goals by all necessary means, often at the cost of the company or organization itself.

[6] *Cf.* Chap. 4. Attributes of food quality and sources of danger in agri-food chains → 4.3. Sources of danger in agri-food chains → 4.3.1. Sources of biological hazards in the agri-food chain

[7] *Op.* in English there is a clear term *food-born disease (s).*

and is applicable in almost all decision-making processes, from intelligence and criminology to the determination of control and critical control points in industrial processes. The term *control point (CP)* is an exact place in the process where the control of a certain factor (factor) that can adversely affect the correctness and safety of any product. By sampling and analyzing the sampled material, this factor is brought under control. The term *critical control point (CCP)* is also a place in the process where control of a certain factor is carried out, but unlike a control point, *at that place this factor is not completely under control because its negative effects can not be determined by standard analyzes and procedures. Their presence above the allowed limits is proven only by additional analyzes or methods*[19]. Questionnaires are already in place today to create a decision tree, and most often, during an interview with an employee of an organization / company, quality auditors will conclude based on their answers whether it is a control or critical control point at a certain stage of the process. In most cases, the assessment of critical control points corresponds to the real situation. However, often times it doesn't, or at least not completely. Therefore, it is necessary to check the credibility of the decision tree.

Phase III

The most effective way to verify the credibility of the decision tree is to apply the *method of Failure Modes and Effects Analysis (FMEA)*[20]. The method is objective because it uses the *Risk Priority Number (RPN)* to determine the risk priority (Equation 1).

$$RPN = S \times P \times D \quad (1)$$

Where is:

RPN – Risk Priority Number

S – represents the severity or importance of negative effects (errors or defects)

P – represents the probability of negative effects (errors or defects)

D – represents the ease of detecting negative effects (errors or defects).

In doing so, the values of severity (*S*), probability (*P*) and ease of detecting errors or defects (*D*) that occur when a particular factor is not under control are determined by the criteria listed in Tables 1, 2 and 3[20].

Table 1. *Performance severity ranking*[20]

Effect	Severity of effect	Severity factor
Danger without warning	Very highly ranked with possible outcome of errors or other negative effects. Affects safety and non-compliance. Adverse effects occur without warning.	10
Danger with warning	Very highly ranked with possible mode of error. Affects safety and non-compliance. An error occurs with a warning.	9
Very tall	Dangerous. The product becomes unusable.	8
High	The product is usable but with the loss of some quality properties. The customer is not satisfied.	7
Mediocre	The product is usable but with the loss of certain benefits. The customer feels uncomfortable.	6
Low	The product is used but with the loss of certain benefits to the extent that the customer feels some discomfort.	5
Very low	Certain product quality properties do not meet specifications, but have been discovered by most customers	4
Low	Certain product quality properties do not meet specifications, but have been discovered by average customers	3
Very low	Certain product quality properties do not meet the specifications, which they found.	2
No	No negative effects	1

Equation 1 includes the values of the severity factors for the severity of the effects (Table 1), and for the probability of occurrence and the ease of detecting errors in the values of the corresponding ranks (Tables 2 and 3).

Table 2. *Ranking the probability of occurrence*

Probability of occurrence	Explanation	Possible error rate *	Rank
Very high	A complete failure of the process	> 1 in 2 products	10
		1 in 3 products	9
Tall	Associated with processes similar to the previous ones that often failed	1 in 8	8
		1 in 20	7
Central	Associated with processes similar to previous processes that have experienced occasional failures or errors	1 in 80	6
		1 in 400	5
		1 in 2000	4
Low	Isolated errors associated with similar processes	1 in 15,000	3
Very low	Only isolated errors associated with almost identical processes	1 in 150,000	2
Weak	Mistakes are unlikely. If there are any, they are not related to similar processes.	<1 at 1,500,000	1

* Error rate is expressed by the number of errors in a given number of products. *Mistakes* are all irregularities of a food product, from the action of a negative factor to the wrong cut of ready-made meat and errors in packaging.

Table 3. *Ranking the ease of detection*

Ease of detection	Explanation	Rang
Absolutely impossible	No available error detection controls are available	10
Very rarely	It is very unlikely that current controls will detect the manner in which the error occurred	9
Rarely	It is unlikely that current controls will detect the manner in which the error occurred	8
Very low	Very low probability that current controls will detect the way errors occur	7
Low	Low probability that current controls will detect the manner in which errors occur	6
Central	Central probability that current controls will detect the manner in which errors occurred	5
Medium high	Moderately high probability that current controls will detect the manner in which errors occur	4
Tall	High probability that current controls will detect the manner in which errors occur	3
Very high	There is a very high probability that the current controls will reveal the way errors occur	2
Quite certain	Reliable controls with similar processes are known, and current controls are certain that errors will be detected.	1

From the above, the general rule is that a higher RPN value in a certain link of the agri-food chain, or in a certain phase of the technological process of production, processing and logistics of food and food products, means higher risk. In doing so, the entire agri-food chain can, moreover, be segmented into smaller parts, ie:

- primary production,
- post-harvest management,
- transport,
- storage of agricultural raw materials in the warehouse of processors,
- processing into food products,
- storage and logistics of food products
- distribution and storage in sales centers.

It should be noted that the RPN may not play a crucial role in the choice of action against the mode of occurrence of errors in the technological process, but will help to identify areas of greatest concentration of errors, or critical control points in them. In other words, errors with a high number of RPNs should be given the highest priority in analysis and corrective actions.

Phase IV
Revision of critical control points in the decision tree based on calculated RPN values. Only after the implementation of phase III is it possible to determine the priority critical control points where the biggest errors occur in all processes, whether it is the inability to control chemical, physical and biological factors that pose a threat to human health, or only about mistakes that do not cause consequences for human health but cause faulty goods and products.

6.3.2 Risk management

Only after all four phases of risk assessment have been carried out is it possible to effectively manage risks. This specifically means:

- Application of *Good agricultural practices (GAP)* in primary agricultural production[21, 22, 23, 24],
- Application of *Good transportation practices (GTP)* for agricultural products[25], fish and shellfish[26, 27], livestock[28], and food products[29],
- Application of *Good manufacturing practices (GMP)*[30].
- Establishment of an adequate *traceability*[8] system
- Establishment of sampling and analytics systems
- Establishment of a documentation system
- Establish procedures to be applied when it is determined that a particular source of danger is not under control.

However, when it comes to risk management, it should be emphasized that the definition and implementation of risk management procedures, but also the implementation of risk assessment procedures, are greatly influenced by *different organizational subcultures* within different stakeholders in agri-food chains, and even within the same stakeholders, ie business and legal entities, within the same agri-food chain. Members of different subcultures may coincide in certain points of view, or may differ completely, and even conflict over some elements of risk assessment and management[31].

Therefore, the concrete engagement of all stakeholders in a particular agri-food chain is needed, but also of all employees within the same business entity in the role of stakeholders, in order to strengthen the culture of quality and strengthen safety in the agri-food chain. For this purpose, a relatively newer method for risk and benefit assessment, better known as *RBA* or full English name *Risk-Benefit Assessment*[32] proved to be useful.

The most effective way to control and manage risks in the agri-food chain is to implement the HACCP system (Hazard Analysis and Critical Control Points) and some quality management systems such as GlobalGAP for primary (agricultural) production and ISO 22 000 for quality management in the food industry.

In any case, it should be kept in mind that the effectiveness of risk management in agri-food chains depends not only on the successful determination and control of biological, chemical and physical factors that pose a food safety risk to consumer health, but also on a whole range of different threats and risks, such as market, health, criminal, political, technological and often neglected behavioral, institutional factors. When these threats are compounded by comparative benefits and costs (including usually neglected third party costs), effective risk management becomes questionable, especially in organizations, agri-food stakeholders who do not have sufficient financial power or human and technical resources to implement one quality management system[33].

The effectiveness of risk management depends primarily on the development of a culture of quality and safety culture of food products in each organization - a stakeholder of the entire agri-food chain. This is achieved through the commitment of management and development of a food safety culture of each employee[34].

[8] *cf.* ch. 1. Agri-food chains →1.6. Traceability in the agri-food chain

6.4 Global good agricultural practice

Global Good Agricultural Practice – Global G.A.P is a brand of smart farm insurance solutions developed by FoodPLUS GmbH in Cologne, Germany, in collaboration with manufacturers, retailers and other stakeholders from across the food industry. These solutions include a range of standards for safe, socially and environmentally responsible agricultural practices. The most commonly used GLOBALG.A.P. standard is Integrated Farm Assurance (IFA), applicable to fruits and vegetables, aquaculture, floriculture, livestock and more. This standard also forms the basis for the GGN label: Consumer label for certified, responsible agriculture and transparency.[9] Namely, the application of the HACCP system principle or hazard analysis and critical control points is not fully applicable in primary production[35]. However, the level of chemical, physical or biological hazard must be effectively assessed at all control points in primary production, whether it is the production of agricultural products intended for further processing into food products or the production of raw materials, ie livestock food. GLOBALG.A.P. started as EUREPGAP in 1997 as the world food retail chains required certification of tropical fruit producers according to the EUREPGAP methodology. To reflect its global reach and goal of becoming a leading international good agricultural practice (GAP), in 2007 EUREPGAP changed its name to GLOBALG.A.P.

Today, more than 200,000 manufacturers are certified by GLOBALG.A.P. standards in 134 countries around the world, which justifies changing the original name of EUREPGAP to GLOBALG.A.P.

The sales sector within the various agri-food chains has a major role to play in raising food quality safety standards to a higher level. In fact, the two voluntary consensus standards, namely the Global GAP and the British Retail Consortium[10] (BRC), are technical standards of wholesalers and retailers of food products and differ from HACCP or ISO standards developed through public bodies or among government agencies. As supermarket chains apply their own food safety standards, each agri-food industry or unit in the agri-food chain must take full responsibility for its own food safety unit. This idea has always been implemented to ensure the credibility as well as the effectiveness of the existing regulatory framework for food quality safety[36]. Therefore, GLOBALG.A.P. was created based on the initiative of food wholesalers (distributors) for those agricultural products that had and have a direct distribution channel to reach consumers. The main reason for launching GLOBALG.A.P. system is the prevention of food incidents, to protect consumer health and avoid paying large damages and penalties in case of acute or chronic consequences for consumer health in case of intoxication with food purchased in a particular food store, which is regulated by food law[37].

6.4.1 Traceability at the farm level through case studies of two food incidents

The first food incident occurred on December 27, 2010, when the first warning was issued by a German citizen from the state of Schleswig-Holstein, via the Rapid Alert System for Animal Feed and Food (RASFF[11]).[12] Namely, approximately 2,300 tons of dioxin-contaminated fat were distributed to 25 feed manufacturers in Germany in 2010. Fatty acids were intended for industrial use (ie for non-food purposes, namely biodiesel). However, the company Harles & Jentzsch in the province of Schleswig-Holstein[13], processed them into fats for animal feed. This alternative use was not allowed. Although the manufacturer was aware of the contamination of the material with dioxins, the countermeasures were not implemented, nor were the authorities informed. The dioxin load in compound feeds was finally detected by routine tests by feed manufacturers who used contaminated fats as feed ingredients. Feed manufacturers immediately notified the competent authorities. It is estimated that the total amount of feed mixtures contaminated with dioxin during 2010 is about 150,000 tons. Manufacturers of compound feeds that used dioxin-contaminated fat were quickly identified. In the first days of January 2011, feed manufacturers in 12 German provinces were affected, leading to the delivery of contaminated batches to approximately 4,760 farms. Some meat and egg samples have

9 https://www.globalgap.org/uk_en/who-we-are/about-us/

10 https://www.brc.org.uk/

11 https://webgate.ec.europa.eu/rasff-window/screen/search

12 https://ec.europa.eu/food/safety/rasff-food-and-feed-safety-alerts_en

13 https://www.cbc.ca/news/world/sales-from-4-700-german-farms-halted-over-dioxins-1.1028572

been found to have higher levels of dioxins than those allowed by EU law. No acute health consequences for consumers have been identified, as approximately 25.4 mg of dioxin has entered the food chain, according to a fact-based mathematical model published by the Federal Ministry of Food, Agriculture and Consumer Protection and the European Commission's Directorate-General for Health and Consumers. However, all products had to be disposed of in environmentally friendly manner. The economic impact, due to reduced consumption of food of animal origin and trade restrictions, was negligible[38].

The second food incident occurred on May 21, 2011, when Germany reported an ongoing epidemic of *Shiga* toxin produced by *Escherichia coli* (STEC), serotype O104: H4. From the initial case control study, the outbreak was related to the consumption of fresh vegetables for salad. Subsequent research has shown that the risk of infection is significantly associated with the consumption of freshly sprouted seeds and not with other fresh vegetables. A back-and-forth follow-up study showed that all cases for which sufficient information was available can be attributed to germinated seeds of fenugreek *(Trigonella foenum – graecum L.)* seed in Germany. Examination of the production site showed no evidence of environmental pollution. Employees were found to be infected, but since they did not become ill before the outbreak, it was concluded that they were not a source of food contamination.

Therefore, the most likely source is contaminated seed used to produce seedlings. Several patients with bloody diarrhea were subsequently reported after attending a local event in France on June 8. Consumption of germinated seeds is also associated with the onset of the disease. *Escherichia coli* (STEC) isolates, which are the cause of disease outbreaks in France and Germany, were found to be indistinguishable. It was therefore concluded that there is a common source for both outbreaks. A comparison of monitoring data on seeds from French and German sources of infection led to the conclusion that a certain consignment of fenugreek seeds *(Trigonella foenum – graecum L.)* imported from Egypt was most likely associated with an outbreak. On July 26, the Robert Koch Institute declared the epidemic over[39].

What was confirmed in both cases?

In both cases it was established that in the basic epidemiological procedure carried out during food incidents, we start from traceability, ie the entire agri-food chain is analyzed and the exact place where contamination with a certain source of danger was observed is determined regardless whether it is a biological, chemical or physical source of danger. Of course, in these two cases it was a biological, or more precisely a microbiological source of danger.

Therefore, when certifying primary food producers according to GlobalG.A.P. standards, great attention is paid to traceability.

6.4.2 Fundamentals of GlobalG.A.P. standard

GLOBALG.A.P. today it is the world's leading program for ensuring the quality of agricultural products, which turns consumer demands into good agricultural practice in an increasing number of countries around the world. The main purpose of GLOBALG.A.P. is to positively influence the world by providing solutions to global problems faced by agricultural supply chains, and this can only be achieved by harmonizing different standards of hygiene and health safety of food, environmental impact and welfare of workers and animals into an independent certification system, specifically GLOBALG.A.P.

There are two certification options per GLOBALG.A.P. standards:

The first option involves the certification of only one large agricultural producer who has organized production in only one location or in several locations of production areas and other production units owned by one producer (eg on several livestock farms, poultry, ponds, orchards, vineyards, on more protected space for growing vegetables and flowers, etc., located in different locations owned by the same manufacturer) with the implementation of *Quality Management System (QMS)* according to GLOBALG.A.P. standards.

The second option involves the certification of several smaller producers whose production areas and farms are located in different locations. In the case of certification under this option, the implementation of a quality management system according to GLOBALG.A.P. standards is mandatory. The second option is

most often chosen by small producers who, due to the placement of their agricultural products (who have a direct distribution channel to the consumer) in large retail chains, at the request of these customers must implement GLOBALG.A.P. standards, as evidenced by GLOBALG.A.P. certificate for a particular agricultural production.

The process of certification of primary producers according to GLOBALG.A.P. standards takes place in five steps:[14]

1. Any manufacturer may download on the GLOBALG.A.P. organization website documentation with relevant standards for individual agricultural production completely free of charge.
2. Each manufacturer may compare the offers of certification bodies registered in their own country or in a neighboring or nearest country. The manufacturer can then register with the certification body of their choice to obtain *GLOBALG.A.P. Number (GGN).*
3. Each manufacturer can, with the help of a selected consultant, conduct a self-assessment on the checklist items, which can be freely downloaded from GLOBALG.A.P. web pages. A consultant can be of great help in self-assessment to correct conditions that manufacturers do not meet.
4. Subsequently, each manufacturer shall agree on the date of the audit when the auditor of the certification body will conduct the audit.
5. When the manufacturer successfully meets the requirements of GLOBALG.A.P. standards for a particular production, the manufacturer receives GLOBALG.A.P. certificate, which will be valid for one year.

Every agricultural producer, regardless of whether their production is certified under the first or second option, extends thes certificate every year, if all the conditions of GLOBALG.A.P. standard are met after audit. GLOBALG.A.P. certificate, also known as the Integrated Farm Quality Assurance (IFA) standard, covers good agricultural practice standards for crop production, aquaculture, livestock and horticultural production. It also covers additional aspects of the food production and supply chain, such as the chain of control and the production of compound feeds.

6.5 Basics of HACCP system

The HACCP (Hazard Analysis and Critical Control Points) system is generally accepted as an efficient and cost-effective tool for ensuring the hygiene and health safety of food in food production and supply chains. The whole idea of HACCP was developed in 1959, when the American food company Pillsbury was given the job of producing food products that could be used in space capsules in gravity-free conditions. The hardest part of the program was to achieve almost 100% assurance that food products manufactured by Pillsbury for astronauts would not be contaminated with bacterial or viral pathogens, poisons, chemicals or any other physical source of danger that could cause illness or injury to astronauts which could lead to the interruption of the mission and even to the catastrophic outcome of the space mission. The basics of today's HACCP system were developed by Pillsbury in collaboration with the National Aeronautics and Space Agency (NASA), the US Army's Natick Laboratory, and the US Air Force Space Laboratory Project Group. In 1997, the World Health Organization recognized the importance of the HACCP principle for the prevention of foodborne diseases. HACCP principles are examples of mandatory standards in the food industry. At the same time, there are many private voluntary food safety management standards, and certification is believed to strengthen the functioning of HACCP in the food business. Examples of Internationally Recognized Private Voluntary Standards are: International Organization for Standardization (ISO) 9001, ISO 22000, British Retail Consortium (BRC), Global Food Safety Initiative Certification Standard, Good Agricultural Practice (Global GAP) or International Food Standard (IFS). However, they also include HACCP as the most important component[41]. Moreover, the HACCP system is applied not only in the food industry but also in the feed industry[42].

[14] https://www.globalgap.org/uk_en/what-we-do/globalg.a.p.-certification/five-steps-to-get-certified/

The HACCP system is based on *seven basic principles:*

6. The principle implies conducting a hazard analysis.
7. The principle implies the identification of critical control points (CCP) in the process in which controls can be carried out in order to prevent, or even eliminate, or reduce hazards to an acceptable level.
8. The principle implies the establishment of critical values for preventive measures to be implemented at each critical control point.
9. The principle implies setting requirements for monitoring critical control points and procedures for using monitoring results to adjust processes and maintain control.
10. The principle implies the establishment of corrective actions to be taken when the monitoring results show that a certain critical control point is not under control.
11. The principle implies the establishment of procedures for additional verification in order to confirm the effectiveness of the HACCP system.
12. The principle implies the establishment of documentation on all implemented procedures and records of all actions applied according to the above stated principles.

The introduction of the HACCP system is carried out through the following actions and procedures:

- *Forming a HACCP team.* In order for the implementation of the HACCP system to be effective, a trained HACCP team is necessary. HACCP team members must be professional and have production-specific work experience necessary to develop a HACCP plan. Responsibilities of the HACCP team include organizing and preparing the necessary documentation, preparing a HACCP study, reviewing deviations from control limits, organizing internal audits of HACCP plans, and communicating, educating and training employees on the operation of the HACCP system.
- *Product description.* The product description should include all information on ingredients, manufacturing process, retail, packaging and storage conditions and associated hazards. Furthermore, the product description requires information on the shelf life of the product, type of packaging, intended use with instructions for preparation and emphasis on the possible effects of this food product on specific populations (infants, immunocompromised individuals, elderly, etc.). In addition, the product description must include information on labeling, storage and distribution conditions.
- *Creating a flow chart.* The flow diagram is prepared by the HACCP team, which should identify all steps of the production process including steps before and after processing of raw materials in the plant.
- *Check the flow diagram on site.* It is implemented by the HACCP team and, if necessary, changes are made to the process flow diagram that correspond to the actual situation.
- *Program prerequisites.* They usually exist before the HACCP plan is developed. These include personal hygiene, good manufacturing practice (GMP), good hygiene practice (GHP), supplier quality assurance, maintenance, training. These should be implemented before assessing the implementation of HACCP.
- *Verification of good manufacturing practice.* This includes general rules on the production, handling and use of various food products.
- *Inspection of buildings, facilities and equipment.* Buildings, facilities and equipment should be located outside the area of environmental pollution, or areas prone to flooding. All buildings must have an adequate supply of drinking water, natural gas, electricity, a well-developed waste management system, ventilation, odor and vapor minimization system, air conditioning and dedusting system.
- *Verification of production and process control.* Raw materials or ingredients must not be accepted into the production process if they have been found to contain parasites, undesirable microorganisms, pesticide residues, antibiotic residues. Raw material quality control should be maintained continuously. Moreover, by reviewing the general condition of trucks used to transport low-moisture raw materials or frozen raw materials. Packaging materials should be hygienic, odorless and not react with either the food contained in it or the surrounding atmosphere. Finished products must be properly marked with product specifications to verify their compliance.
- *Establishment of control measures.* Control measures include program prerequisites and are essential for hazard screening at critical control points.

- *Determine critical control points (CCPs) and critical values in them.* An effective tool used in risk assessment, known as the *decision tree*,[15] is used to determine critical control points[18].
- *Development of HACCP plan.* The HACCP coordinator and the HACCP team for the development of the HACCP plan are responsible for the development of the HACCP plan. The HACCP plan must identify the sources of the various food safety hazards to be controlled in each CCP. Control measures, critical values, method of monitoring procedures, corrective actions if CLs do not have control, responsibilities and authorities, and process monitoring records must also be listed.
- *HACCP plan verification.* HACCP plan verification activities should confirm that the program prerequisites have been properly implemented and that the HACCP plan has been effectively implemented in all its elements.
- *Establishment of a traceability system,* as described in detail in ch. 1. Agri-food chains → 1.6. Traceability in the agri-food chain.
- *Defining corrective actions* to be taken in case of non-compliance, as described in detail in 1. Agro-food chains → 1.6. Traceability in the agri-food chain → point 5. Product recall.

However, once the HACCP system is established, the work of the HACCP team never ends. Namely, *the successful implementation and enforcement of the HACCP system implies its continuous testing and improvement,* and this is exactly what makes it sustainable. Continuous inspection and improvement procedures are also the most difficult part of the job[43].

6.6 BRC, IFS and ISO 22 000 food quality and safety management systems

As consumer interest in food safety has increased, so have food quality and safety management systems. Thus, in 1998, the *British Retail Consortium*[16] *(BRC),* in coordination with major UK retailers such as TESCO and Sainsbury, set standards for conducting quality audits of food suppliers. Each audit is conducted by certified organizations.

Prior to the introduction of the BRC standard, retailers conducted their own individual inspections. However, it soon became clear that joint inspections were cost-effective. Recently, the introduction of BRC standards has been demanded by retailers based in other European countries, and some of them have required their suppliers to revise their *Food Safety and Quality Standards* in line with BRC standards, and to provide relevant certification report data. *All HACCP system requirements are included in the BRC standards,* although more emphasis is placed on documentation, plant condition, product and process control procedures, and personnel.

Today, BRC standards are accepted by many food retail chains, service companies and food manufacturers around the world. Since 2015, translations of the Global Food Safety Standard have been available in many languages[44].

The basic elements of the BRC standard – BRCv7 are:

- assessment of the commitment of management and senior management to quality development (BRCv7 c.1.0),
- assessment of the food safety system – HACCP (BRCv7 c.2.0),
- inspection of the food safety and quality management system, ie inspection, documentation, registers, records, internal audit reports, supplier monitoring, specifications, traceability, corrective actions and incident management (BRCv7 c. 3.0),
- verification of construction standards related to; factory location, product flow and separation, construction work requirements, equipment maintenance, control of chemical and physical contamination of products, handling of raw materials and intermediates, preparation, processing, packaging and storage, types of control actions and procedures (BRCv7 c. 4.0),

[15] *cf.* Chap. 6.3.1. Risk assessment →Phase II

[16] https://brc.org.uk/about/

- product control (BRCv7 c. 5.0),
- process control (BRCv7 c. 6.0),
- hygienic control of staff (BRCv7 c. 7.0)[45, 46].

IFS or *International Featured Standards*[17] were introduced by German and French wholesale associations and joined by their Italian counterparts. The purpose of IFS is to develop a consistent evaluation system for all organizations that supply food products of brands[44].

The goal of IFS food standards certification is to assess the ability of manufacturers to produce food products that are safe, legal and in accordance with customer specifications. That is why the safety of food products and their quality are the most important component of all IFS standards, including Food Standards. The IFS assessment is product and process focused and ensures that the development of high quality products is achieved through appropriate functional processes[47]. In essence, IFS dietary standards do not differ much from BRC dietary standards.

ISO 22 000: 2018[18] food quality and safety management system ISO 22 000 was developed as a solution to improve food safety, instead of applying good manufacturing practice, which will international trade[48]. The basic elements of quality assessment according to ISO 22 000 standards are:

1. Structure and layout of buildings and related utilities
2. Layout of premises, including workspace and premises for employees
3. Stocks of air, water, energy and other utilities
4. Ancillary services, including waste and sewage disposal
5. Suitability and availability of equipment for easy cleaning, repair and preventive maintenance
6. Management of materials (eg raw materials, ingredients, chemicals and packaging), stocks (eg water, air, steam, and ice), disposal (eg waste and sewage), handling of processing and products (eg storage and transport);
7. Measures to prevent cross-contamination
8. Cleaning and disinfection
9. Pest control
10. Personal hygiene
11. Staff training
12. Other aspects, as appropriate.

The main advantages of the ISO 22 000 food quality management system are the following:

- provides some requirements that can be applied to any organization in the food chain in any country,
- is an internationally recognized standard,
- is subject to audit,
- allows a flexible approach, as organizations can choose which methods to use to meet ISO 22 000 requirements,
- can be independently applied to another food quality management system,
- can be easily integrated with another, already implemented quality management system, such as the HACCP system, which is a legal obligation,
- enables implementation in less developed organizations,

Through ISO 22 000, a combination of control measures has been developed, which enables efficient assessment and management of all risks[49].

[17] https://www.ifs-certification.com/index.php/en/standards/4128-ifs-food-standard-en

[18] https://www.iso.org/standard/65464.html

6.7 Social responsibility of stakeholders in the agri-food chain as a quality criterion

One of the unavoidable criteria in assessing the quality of stakeholders in the agri-food chain is the social responsibility of stakeholders in the agri-food chain. It is clearly explained in the United Nations document "Sustainable Development Goals"[19][50] and is derived from UN Resolution no. 70/1, adopted by the United Nations General Assembly on 21 October 2015[51].

The resolution defines a total of 17 sustainable development goals[20] and the International Organization for Standardization has adopted the ISO 26 000: 2010 "Guide to Social Responsibility".[21][52] ISO 26000: 2010 is not a management system standard. Moreover, it is not intended or suitable for certification purposes or regulatory or contractual use. ISO 26000: 2010 is a useful tool to help organizations contribute to the 17 goals of sustainable development, and it is intended to encourage organizations to go beyond compliance, recognizing that compliance is a fundamental duty of every organization and an essential part of their social responsibility[53].

Bibliography

[1] Evans, J. R., Lindsay, W. M. (1996) The Management and Control of Quality. 3rd edition, West Publishing Company. St. Paul. Minnesota, USA. 767 p.
[2] Garvin, D. A. (1988) Managing Quality: The Strategic and Competitive Edge. The Free Press. New York, USA. 319 p.
[3] Luning, P. A., Marcelis, W. J. (2006) A techno-managerial approach in food quality management research. Trends in Food Science & Technology, 17, 378–385. https://doi.org/10.1016/j.tifs.2006.01.012
[4] Luning, P. A., Marcelis, W. J. (2009) A food quality management research methodology integrating technological and managerial theories. Trends in Food Science & Technology, 20, 35–44. https://doi.org/10.1016/j.tifs.2008.09.013
[5] Moen, R., Norman, C. (2009) Evolution of the PDCA Cycle. "The History of the PDCA Cycle." In Proceedings of the 7th ANQ Congress, Tokyo 2009, September 17, 2009.
[6] Antunes Júnior, A., Broday, E. E. (2019) Adopting PDCA to Loss Reduction: A Case Study in a Food Industry in Southern Brazil. International Journal for Quality Research, 13, 335–348. https://doi.org/10.24874/IJQR13.02-06
[7] Samuelson, P. A., Nordhaus, W. D. (2004) Economics. McGraw-Hill, New York, USA. pp. 3–17.
[8] Friedman, M. (1970) Essays in Positive Economics. The University of Chicago Press, Illinois, USA. pp. 3–43.
[9] Luning, P., Marcelis, W., van der Spiegel, M. (2007) Quality assurance systems and food safety. Chapter in book: Safety in the agri-food chain. Luning, P. A., Devlieghere, F., Verhé, R. (eds.). Wageningen Academic Publishers. The Netherlands. pp. 249–299.
[10] Luning, P. A., Marcelis, W. J., Rovira, J., Van der Spiegel, M., Uyttendaele, M., Jacxsens, L. (2009) Systematic assessment of core assurance activities in a company specific food safety management system. Trends in Food Science & Technology, 20, 300–312. https://doi.org/10.1016/j.tifs.2009.03.003
[11] Deming, E. W. (1986) Out of Crisis. MIT, Center for Advanced Engineering Study, Cambridge, Massachusetts, USA. 507 p.
[12] Gartner, W. B. (1993) Dr. Deming Comes to Class. Journal of Management Education, 17, 143–158. https://doi.org/10.1177/105256299301700201
[13] Deming, E. W. (2018) The New Economics for Industry, Government, Education. Third Edition. MIT, Center for Advanced Engineering Study, Cambridge, Massachusetts, USA. 240 p.
[14] Mack, A., Schmitz, T., Schulze Althoff, G., Devlieghere, F., Petersen, B. (2007) Sreps in the risk management process. Chapter in book: Safety in the agri-food chain. Luning, P. A., Devlieghere, F., Verhé, R. (eds.). Wageningen Academic Publishers. The Netherlands. pp. 355–396.
[15] Boye, J. I., Danquah, A. O., Cin Lam Thang, Zhao, X. (2012) Food Allergens. Chapter in book: Food Biochemistry and Food Processing, Second Edition. Simpson, B. K. (ed.). John Wiley & Sons, Inc. pp. 798–819. https://doi.org/10.1002/9781118308035
[16] Harada, M., Akagi, H., Tsuda, T., Kizaki, T., Ohno, H. (1999) Methylmercury level in umbilical cords from patients with congenital Minamata disease. The Science of the Total Environment, 234, 59–62.
[17] Ráduly, Z., Szabó, L., Madar, A., Pócsi, I., Csernoch, L. (2020) Toxicological and Medical Aspects of Aspergillus-Derived Mycotoxins Entering the Feed and Food Chain. Frontiers in Microbiology, 10, 2908. https://doi.org/10.3389/fmicb.2019.02908
[18] Magee, J. F. (1964) Decision Trees for Decision Making. Harvard Business Review, 42, 126–138.
[19] Humber, J. (1992) Control Points and Critical Control Points. Chapter in book: HACCP: principles and applications. Pierson, M.D., Corlett, D.A., Jr. (eds.). Chapman & Hall. Lodnon, UK. 97–104. https://doi.org/10.1007/978-1-4684-8818-0
[20] Kiran, D. A. (2017) Total Quality Management: Key Concepts and Case Studies. Chapter 26: Failure Modes and Effects Analysis. Butterworth Heinemann, Elsevier. Oxford, UK. 373–389. https://doi.org/10.1016/C2016-0-00426-6
[21] Swanson, B. E. (2008) Global Review of Good Agricultural Extension and Advisory Service Practices. FAO, Rome. 64 p.
[22] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.521.3652&rep=rep1&type=pdf

19 https://sdgs.un.org/goals

20 https://sdgs.un.org/goals

21 https://www.iso.org/standard/42546.html

[23] Rodrigues, R. de Quadros, Loiko, M. R., de Paula, C. M. D., Hessel, C. T., Jacxsens, L., Uyttendaele, M., Bender, R. J., Tondo, E. C. (2014) Microbiological contamination linked to implementation of good agricultural practices in the production of organic lettuce in Southern Brazil. Food Control, 42, 152–164. https://doi.org/10.1016/j.foodcont.2014.01.043
[24] Marine, S. C., Martin, D. A., Adalja, A., Mathew, S., Everts, K. L. (2016) Effect of market channel, farm scale, and years in production on mid-Atlantic vegetable producers' knowledge and implementation of Good Agricultural Practices. Food Control, 59, 128–138. https://doi.org/10.1016/j.foodcont.2015.05.024
[25] Parikhani, M. P., Borkhani, F. R., Fami, H. S., Motiee, N., Hosseinpoor, A. (2015) Major Barriers to Application of Good Agricultural Practices (GAPs) Technologies in Sustainability of Livestock Units. International Journal of Agricultural Management and Development, 53, 169–178. https://doi.org/10.5455/ijamd.161640
[26] Rajabion, L., Khorraminia, M., Andjomshoaa, A., Ghafouri-Azard, M., Molavi, H. (2019) A new model for assessing the impact of the urban intelligent transportation system, farmers' knowledge and business processes on the success of green supply chain management system for urban distribution of agricultural products. Journal of Retailing and Consumer Services, 50, 154–162. https://doi.org/10.1016/j.jretconser.2019.05.007
[27] Parvathy, U., Ankur Nagori, Binsi, P. K., Ravishankar, C. N. (2020) Transportation Prototype for Live Distribution of Mud Crab in Seafood Supply Chain. Fishery Technology, 57, 69–71. https://krishi.icar.gov.in/jspui/bitstream/123456789/36746/1/Transportation%20Prototype%20for%20Live%20Distribution.pdf
[28] Martins, W. S., Leite, A. B. de C., Martins, R. L., da Silva, J. O., Balian, S. de C. (2019) Assessment of Frozen Seafood Good Storage Practices in the 21st Supply Deposit of the Brazilian Army. Brazilian Journal of Veterinary Research and Animal Science, 56, e151385. https://doi.org/10.11606/issn.1678-4456.bjvras.2019.151385
[29] Buddle, E. A., Bray, H. J., Ankeny, R. A. (2018) "I Feel Sorry for Them": Australian Meat Consumers' Perceptions about Sheep and Beef Cattle Transportation. Animals, 8, 171; https://doi.org/10.3390/ani8100171
[30] Chapman, B. J., Linton, R. H., McSwane, D. Z. (2021) Food safety postprocessing: Transportation, supermarkets, and restaurants. Chapter in book: Foodborne Infections and Intoxications. J. Glenn Morris, Jr., Vugia, D. J. (eds.). Academic Press, Elsevier. 523–544. https://doi.org/10.3390/ani81001710.1016/B978-0-12-819
[31] De Oliveira, C. A. F., da Cruz, A. G., Tavolaro, P., Corassin, C. H. (2016) Food Safety: Good Manufacturing Practices (GMP), Sanitation Standard Operating Procedures (SSOP), Hazard Analysis and Critical Control Point (HACCP). Chapter in book: Antimicrobial Food Packaging. Barros-Velázquez, J. (ed.). Academic Press, Elsevier. 129–139. https://doi.org/10.1016/B978-0-12-800723-5.00010-3
[32] Manning, L. (2017) The Influence of Organizational Subcultures on Food Safety Management. Journal of Marketing Channels, 24, 180–189. https://doi.org/10.1080/1046669X.2017.1393235
[33] Assunçãao, R., Pires, S. M., Nauta, M. (2019) Risk-Benefit Assessment of Foods. EFSA Journal, 17(S2): e170917, 8 p. https://doi.org/10.2903/j.efsa.2019.e170917
[34] Bachev, H. (2012) Risk Management in the Agri-food Sector. Contemporary Economics, 7, 45–62. https://doi.org/10.5709/ce.1897-9254.73
[35] Nyarugwe, S. P., Linnemann, A. R., Luning, P. A. (2020) Prevailing food safety culture in companies operating in a transition economy - Does product riskiness matter? Food Control, 107, 106803. https://doi.org/10.1016/j.foodcont.2019.106803
[36] Cerf. O., Donnat, E. (2011) Application of hazard analysis – Critical control point (HACCP) principles to primary production: What is feasible and desirable? Food Control, 22, 1839–1843. https://doi.org/10.1016/j.foodcont.2011.04.023
[37] Okpala, C. O. R., Korzeniowska, M. (2021) Understanding the Relevance of Quality Management in Agro-food Product Industry: From Ethical Considerations to Assuring Food Hygiene Quality Safety Standards and Its Associated Processes. Food Reviews International, https://doi.org/10.1080/87559129.2021.1938600
[38] EC (2002) Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. http://data.europa.eu/eli/reg/2002/178/oj
[39] Zentek, J., Knorr, F., Mader, A., Schafft, H. (2012) Lessons from the large-scale incident of animal feed contamination with dioxins in Germany in 2011. Chapter in book: Case Studies in Food Safety and Authenticity. Hoorfar, J. (ed.). Woodhead Publishing. 296–300. https://doi.org/10.1533/9780857096937.6.296
[40] European Food Safety Authority (2011) Shiga toxin-producing E. coli (STEC) O104:H4 2011 outbreaks in Europe: Taking Stock. EFSA Journal, 9(10), 2390. https://doi.org/10.2903/j.efsa.2011.2390
[41] Bauman, H. E. (1992) Introduction to HACCP. Chapter in book: HACCP: principles and applications. Pierson, M. D., Corlett, D. A., Jr. (eds.). Chapman & Hall. Lodnon, UK. 1–5. https://doi.org/10.1007/978-1-4684-8818-0
[42] Trafialek, J. (2016) Implementation and functioning of HACCP principles in certified and non-certified food businesses. A preliminary study. British Food Journal, 119, 710–728. https://doi.org/10.1108/BFJ-07-2016-0313
[43] Den Hartog, J. (2003) Feed for Food: HACCP in the animal feed industry. Food Control, 14, 95–99. https://doi.org/10.1016/S0956-7135(02)00111-1
[44] Varzakas, T. (2016) HACCP and ISO22000: Risk Assessment in Conjunction with Other Food Safety Tools Such as FMEA, Ishikawa Diagrams and Pareto. Encyclopedia of Food and Health, Reference Module in Food Science. 295–302. https://doi.org/10.1016/B978-0-12-384947-2.00320-2
[45] Kotsanopoulos, K. V., Arvanitoyannis, I. S. (2017) The Role of Auditing, Food Safety, and Food Quality Standards in the Food Industry: A Review. Comprehensive Reviews in Food Science and Food Safety, 16, 760–775. https://doi.org/10.1111/1541-4337.12293
[46] Miarka, D., Urbańska, B., Kowalska, J. (2019) Traceability as a tool aiding food safety assurance on the example of a food-packing plant. Accreditation and Quality Assurance, 24, 237–244. https://doi.org/10.1007/s00769-018-01370-8
[47] British Retail Consortium, BRC (2015) Global Standard Safety ISSUE 7. London. https://www.brcgs.com/media/63848/brc_global_standard_for_food_safety_issue_7_faqs-1.pdf
[48] Internationa Featured Standards (2020) Standard for assessing product and process compliance in relation to food safety and quality, version 7.
[49] https://www.ifs-certification.com/index.php/en/standards/4128-ifs-food-standard-en
[50] Panghal, A., Chhikara, N., Sindhu, N., Jaglan, S. (2018) Role of Food Safety Management Systems in safe food production: A review. Journal of Food Safety, 38, e12464. https://doi.org/10.1111/jfs.12464

[51] Petró-Turza, M. (2014) Institutions involved in foodsafety. Encyclopedia of Human Nutrition, 4, 379–383. https://doi.org/10.1016/B978-0-12-378612-8.00392-9
[52] ISO (2018) Contributing to the UN Sustainable Development Goals With ISO Standards. ISBN 978-92-67-10790-5. https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100429.pdf
[53] UN (2015) 70/1. Transforming our world: the 2030 Agenda for Sustainable Development. https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

DOI: 10.54597/mate.0065
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CHAPTER 7

Network analysis solutions in the agri-food sector

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7.1 Definition, concept, mainstream applications

Deriving from social network (analysis) network studies and science have evolved to many areas of life, such as DNA mapping, logistics or marketing researches.

When thinking about the world in terms of different overlaying networks that connect and transfer friendships, information, money, and power – it becomes obvious that looking at things through the analysis of social networks can lead to a new realization on many interesting topics. Just think some of the following examples that are commonly understood as network concepts, such as online or more traditional social networks of people, degrees of Kevin Bacon the actor, or the way how Facebook algorithms predict products or friends to be offered. We have an intuitive sense that the connections of the people around us are a huge factor[1].

Why to rely on network analysis?

The standard statistical methods would not be effective enough without looking at connections of the social network[2]. Similarities and differences between isolated data points do not, but social networking data analysis gives us tools to quantify those connections between individual points so that we can find patterns in the forces that connect us as a society. If the researchers can find out how one person connected to or disconnected from people, groups, and trends in a population and all those people who seems to be friends with everyone, they are able to reveal individuals in populations that bridge social groups.

In a more practical way of looking at the topic, it is interesting for specific decision makers to gain information on what makes a group of strangers start to form statement groups, what networks are firm, how things like power, beliefs, or even an outbreak of disease flows through the individual connections. These practical questions may be atrgete with quantitive answers and new insights with social network analysis.

How network analysis and science evolved?

Social network analysis is a very open field and there are lots of technical options to try out. Like adding geographic mapping data to understand how physical environments change network dynamics. For businesses on online social media, understanding how people connect (react or otherwise learn) your busniess activities or what information on these people is available can be crucial in your business prosperity.

The rise in computation and emergence of mass of new data sources facilitated social network analysis. Social network analysis is the application of network theory to the modeling and analysis of social systems. It combines the tools for analyzing social relations and the theory for explaining the structures that emerge from these social interactions.

Social networks are studies as ones composed of individuals and organisations, and the aim of the analsis is to quantitatively describe these entities in a formal mathematical language of statistical analysis. Network science adds information on cause-and-reason analysis by capturing the most important feature of social reality that is the relations between individuals.

Network science analyzes empirical data and develops theories to explain the patterns observed in these networks. Such questions are asked as the degree of connectivity within a network, its overall structure how far something will diffuse or propagate through it, or the influence of a given node within the network[3].

7.2 Network analysis in agrifood sector

Applications of network analysis

Social network analysis has already been used to study the *structure of influence within corporations.* Findings might be surprising when modeling the actual flow of information and communications as a network gives a very different picture on seemingly irrelevant employees within the hierarchy who can in fact have significant influence within the network.

Researchers also study *innovation as a process of diffusion of new ideas across networks* where the overall structure to the network is degree of connectivity, centralization or decentralization.

Network dynamics that is how networks evolve over time is another important area of research for example. Social network analysis is used to study the change in structure of terrorist groups to identify the changing relations through which they are created, strengthened or dissolved.

Social network analysis has also been used to study the patterns of segregation and clustering within international politics and culture. By mapping out the beliefs and values of countries and cultures as networks we can identify where opinions and beliefs overlap or conflict. This can be useful for international companies outreaching to sveral cultures with their subdivisions.

Social network analysis is a powerful new method that allows us to convert often large and dense datasets into engaging visualizations that can quickly and effectively communicate the underlying dynamics within the system.

Social network analysis is offering a huge potential for a deeper, richer and more accurate understanding of the complex social systems that make up our world[2].

7.2.1 Networks of the socio-environmental-economic production space

First of all we need to understand how networks are complied. In order to see clearly the elements of a network this chapter shortly introduces the basic vocabulary and statistics of network structures.

Nodes

Nodes or points in a network or diagram are elements at which lines or pathways intersect or branch. In the below articular case there are two nodes (Node2 and Node5) linked.

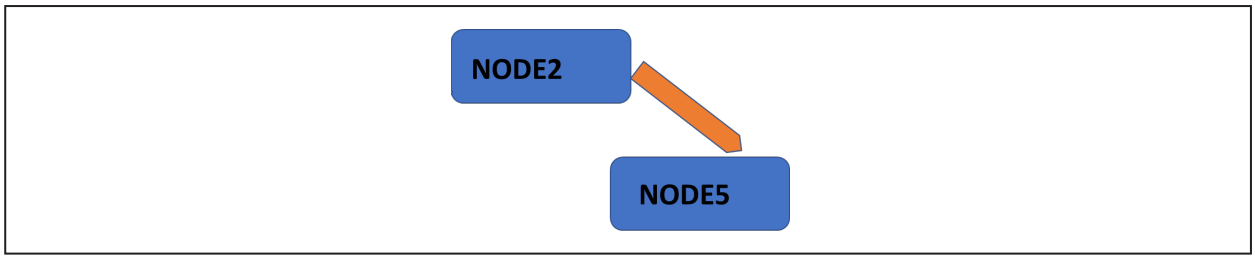

Figure 1. *Pair of nodes with link*

Edges

Edges or links are the pathways between or across the nodes of a network. For instance, in the below graph, Edge1 goes from Node1 to Node2 and so on.

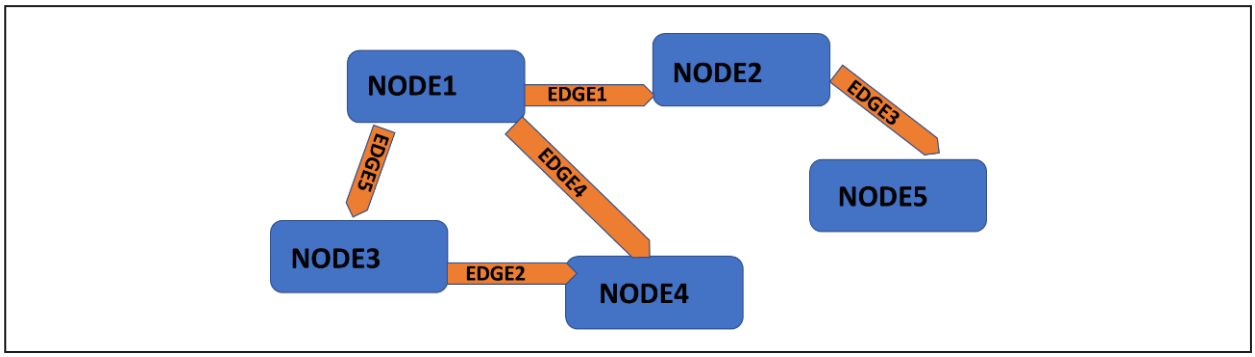

Figure 2. *Links of nodes in a simplified model*

Degrees

The term degree expresses the number of links or edges reaching the intersects presented by the nodes; it measures the direct connections of a node with other ones. Actually the degree of a node gives an insight how well this particular node is connected to the others. In the above example, Node1 has 3 degrees as it is connected directly to three further nodes (Node2, Node3 and Node4).

Degree distribution

A common way that we describe networks is by giving a degree distribution. The degree distribution is simply a tally of how many nodes have each degree.

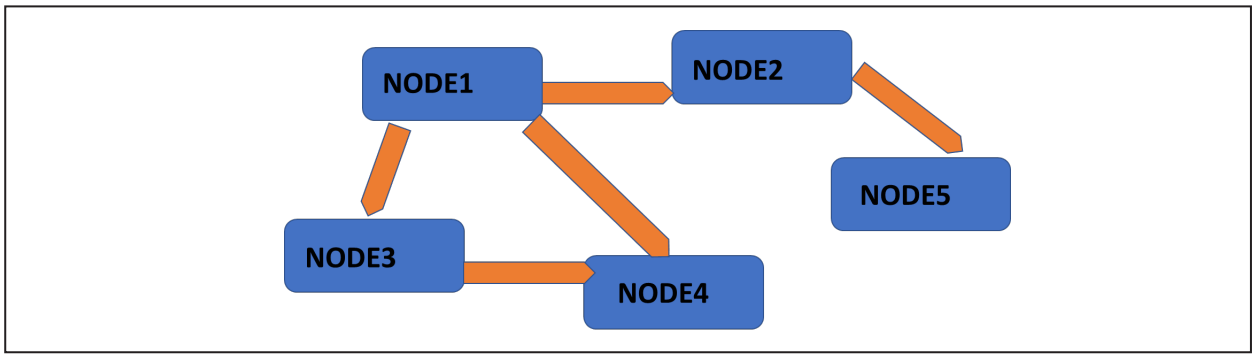

Figure 3. *Sample network with directed edges*

Given the above simple network of five nodes (Figure 3), you may count the in or out going edges (links) for each individual node.

For example, Node1 has three direct connections (to Node2, Node3 and Node4), that is Node1 has 3 degrees. Node5 has only ne direct connection, which goes from Node2, that is Node4 has one degree.

Te degree distribution is simply the tally of the degrees: how many nodes has 1 degree, 2 degrees, etc...

In the above example, the tally of degrees (number of nodes with given number of degrees): 1 degree: 1; 2 degrees: 3; 3 degrees: 1; 4 degrees: 0...

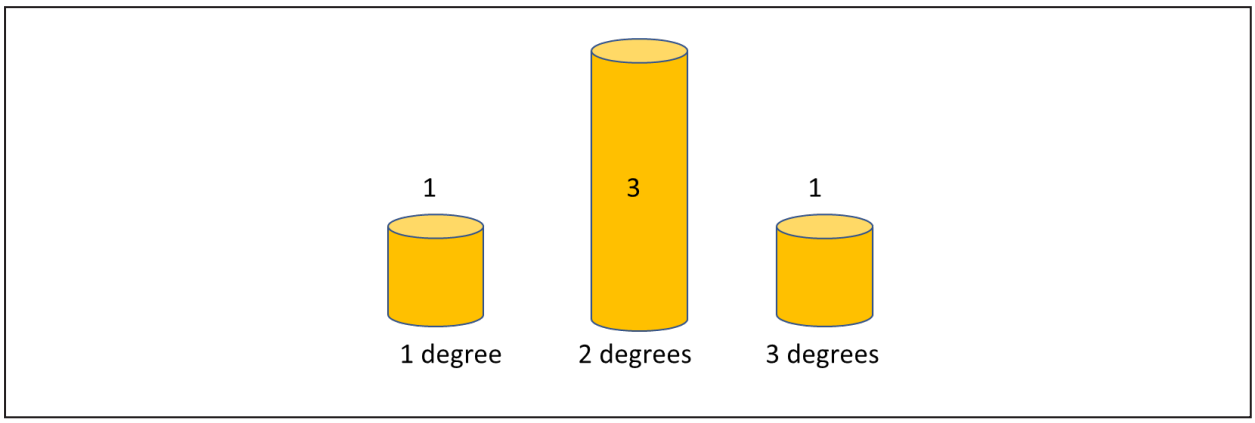

Figure 4. *Degree distribution of the sample network*

When putting the number of nodes on the graph of the degree distribution, you see the number of degrees on the x axis. In this case 3 is our highest degree. The y-axis is the number of nodes with that degree. In our case it is 1 for 3 degrees, 3 for 2 degrees and 1 for 1 degree.

There is a way also to differentiate between in and out degrees in a directed graph. If you count the incoming and outgoing links of each node you will get the degree distribution separately for in and out degrees.

In the above example, the tally of in-degrees (number of nodes with given number of in-degrees): 1 indegree: 3; 2 indegrees: 1; 3 indegrees: 0

Also, the tally of out-degrees (number of nodes with given number of out-degrees): 1 outdegree: 2; 2 outdegrees: 0; 3 outdegrees: 1

It is because 1 indegree you can see in case of Node2, Node3, Node5, 1 outdegree is for Node2 and Node3, etc.

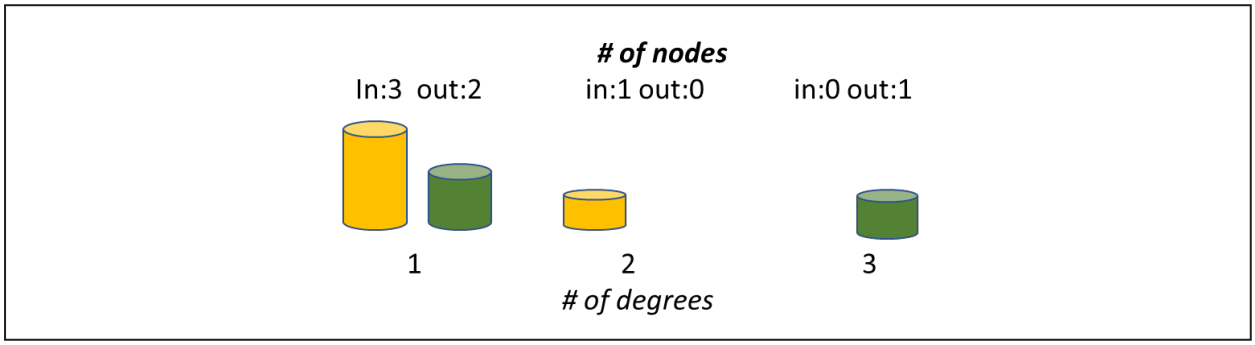

Figure 5. *In and out degree distribution of sample network*

As you can see, there is no nodes with an outdegree of 2 or indegree of 3. But there are 3 nodes with 1 indegree and 2 nodes with 1 outdegree. Also there is 1 node with 3 outdegree.

This is a very simple example. In a network like let's say for example Facebook theer would be a wide range of degrees – as there are people with tens of thousands of friends. In such a complex case the the x-axis for the degree distribution would start also at 0 because there are people with no friends and go up to say a hundred thousand, if there were a case that someone could have that many friends.

Below there is an example of a network of high number of nodes: many modes with very low number of connections (degrees), while very low number of nodes with really huge number of connections.

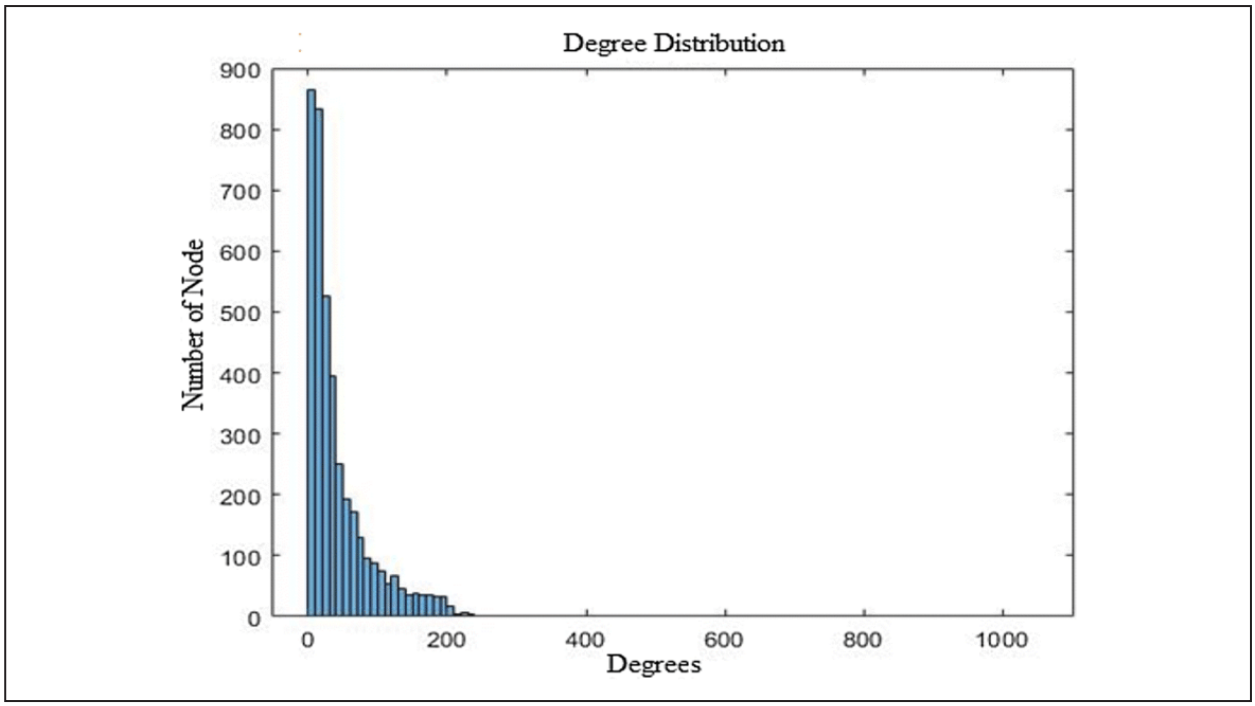

Figure 6. *The power law distribution of networks*

This distribution is called a power-law distribution; unlike the normal distribution it peaks at low x values. Networks tend to follow a power law distribution (instead of a bell curve). Compare the two graphs:

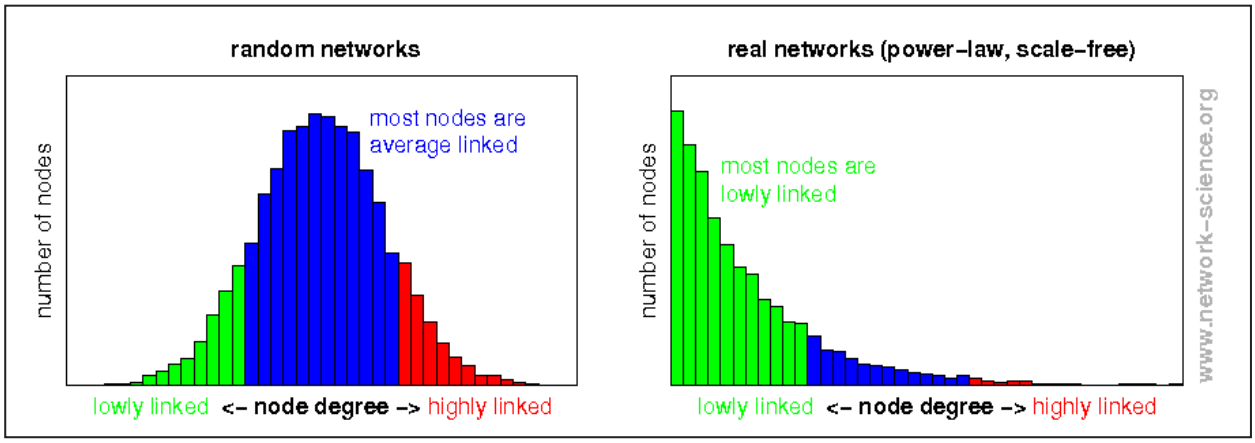

Figure 7. *Random vs. real networks distribution*
Source: www.network-science.org

In networks called random networks with normal degree distribution, most nodes are average linked, but in case of so called real networks, most nodes are low linked.

Besides social networks, book sales is a good example for power law distribution. A lot of books have very low sales but as the sales get higher the number of books with those sales gets lower. So there are definitely books out there that have really high sales but most books are in the lower portion.

7.2.2 Actors and links in agribusiness value chain analysis

Now we understand nodes and edges and degrees of nodes displaying the aount of connections between them. Let's see some of the useful techniques that describes the way how a network is connected and most importantly what these pieces of information on connectedness mean for a practicioner.

Density

Another way of understanding a network is by its density. Density is essentially measuring how many edges are there versus how many edges could there possibly be. In the below example the same network is used with its 5 given edges, but futher 5 possible edges (blue lines) are added to the network.

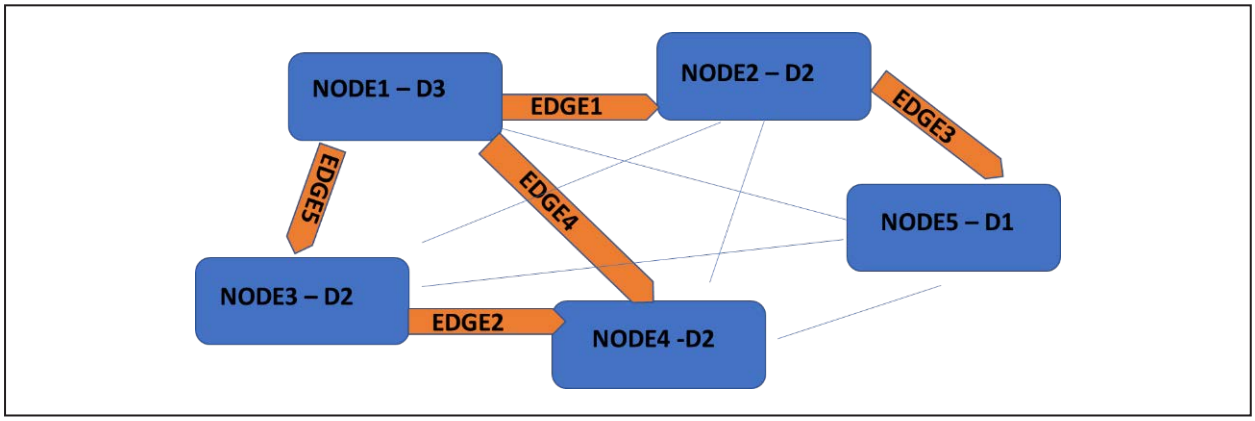

Figure 8. *Density of a network*

So to compute the density we need to know how many edges there are: in this case 5. The number of possible edges – how many possible edges are there if every node were connected to every other node can be defined by the formula of total links.

1 node may have connections to further 4 nodes, which for the case of five nodes gives 4 times 5 connections. This number has to be divided by two, as a link between Node 1 and Node 2 is the same as the link between Node 2 and Node 1.

In the above case we can count five edges that exist and we can count five additional edges: so 10 total edges. The density is then 5 over 10 that is 0.5.

In a realistic network, the densitiy is a low number, normally it is lower than 0.1 or 10%, or even much lower (Facebook has a density of 0.0001). The bigger the network is, the lower the density of it.

Clustering coefficient

There's another way that we can use density to understand networks. The clustering coefficient is a measure to see how well the rest of the network is connected if we remove a certain node. In the following example we take out the one node, let it be Node3 and its connections: Edges5 and 2. What remains is the following.

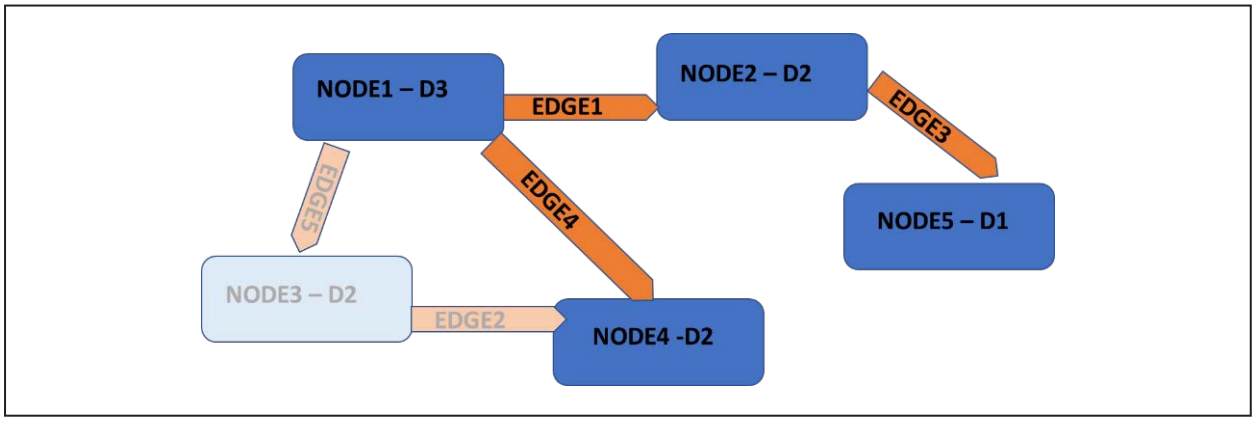

Figure 9. *Remaining part of model network if excluding Node3 and its edges*

We have to calculate only the nodes and connections without Node3. It is easy to admit, that the bigger share of connections remain the less important the removed node was.

Importance of nodes

The way of understanding the importance of nodes in a network gives further information on the network. Let's see the following question: which node is supposed to be considered as most important in this network.

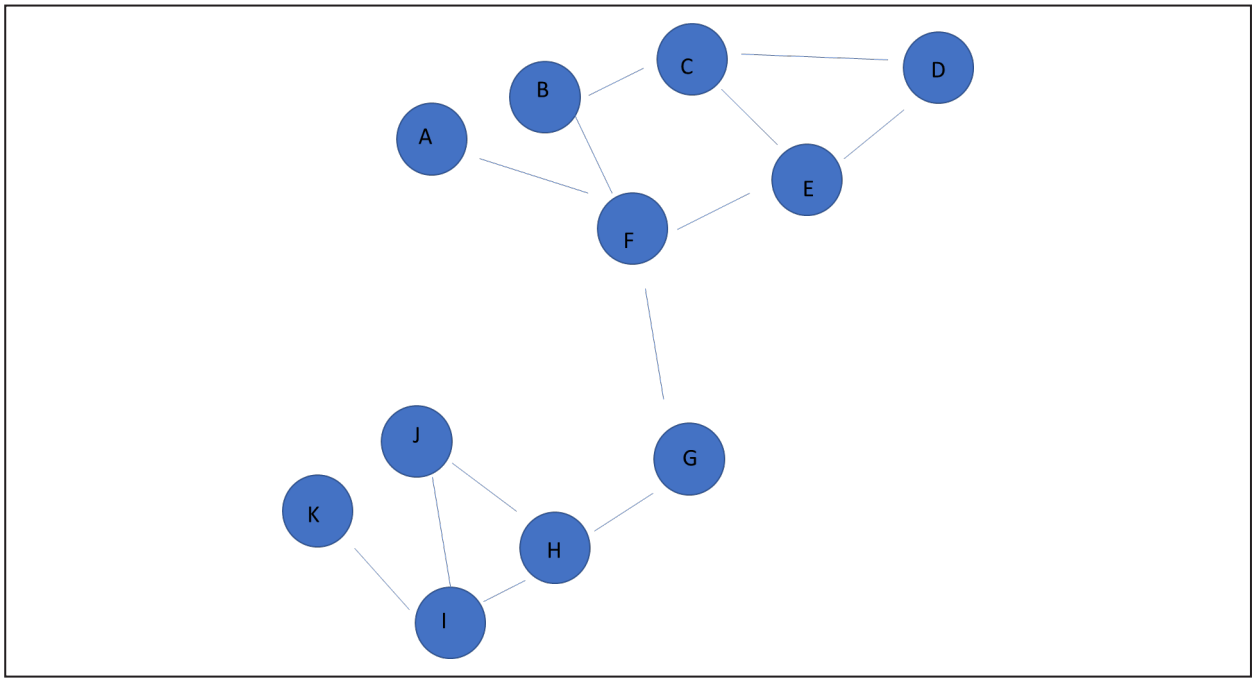

Figure 10. *Sample network of 11 nodes*

Most obvious answers could be Node F or Node G. Node G because it links two big parts of the network and Node F as it has a high number of connections.

Both intuition is right, they are central nodes from different aspects. There are centrality measures that support certain arguments on importance of nodes. When looking at a network, we need to know what each centrality measure means, what is good for measuring and then to be able to make an argument why that centrality measure is the most appropriate for the target of the analysis.

Centrality measures

Centrality is a way of measuring the importance of nodes in a network and there's a variety of ways of doing that. It is possible that they show different nodes to be more important.

Closeness centrality

One of the easiest measures to understand is closeness centrality, which is just the average of the shortest path lengths from one node to every other node in the network. Looking at the above example, let's choose Node F for this exercise. Node A and Node B are 1 shortest path lengths from Node F, as they are directly linked to it. To get to Node C the shothest path takes through either Node B or Node E, therefore the shortest path from Node F to Node C is 2. The following table lists all the shortest path lengths from Node F to every other Node in the network.

Table 1. *Illustration of shortest paths lengths from NodeF*

Node	shortest path length from Node F
A	1
B	1
C	2
D	2
E	1
G	1
H	2
I	3
J	3
K	4

Closeness centrality is simply the average of these shortest path lengths: the sum of the shortest path lengths is 1+1+....3+3=20, to get the average divide it with 10 (being the number of the nodes except for Node F), thus the closeness centrality for Node F is 2.

By calculating the same measure, we find that all the other nodes have higher closeness centrality (CC) values:

CC (F) = 2.0

CC (H) = 2.4

CC (D) = 3.2

....

From the aspect of closeness centrality the most important node in this network is Node F as it is the *closest one to every other node.*

Closeness centrality is really designed to be a centrality measure that looks at how close a node is to every other node in the network. It doesn't measure how big its degree is, it just informs us that it's closely connected to a lot of other nodes. Thios sort of information can be really important for example if we're looking at how diseases or innovation spread.

Degree centrality

Degree centrality is the easiest measure to compute and it is simply the degree of a node. In the above example, according to degree centrality Node F is most central, and Nodes H, I, C and E are coming in second. Nodes A and K are the last with a degree of 1. According to degree centrality what we are really looking for are well connected nodes. So it doesn't matter what role they play in the rest of the network the information on how well connected are they to other people is important.

Betweenness centrality

Betweenness the centrality is one of the most widely used centrality measures when analyzing social networks. The basic intuition is that Betweenness the centrality gives the percentage of shortest paths that include a given note. Let's take the example of Node F and calculate how many of the shortest paths include this particular node.

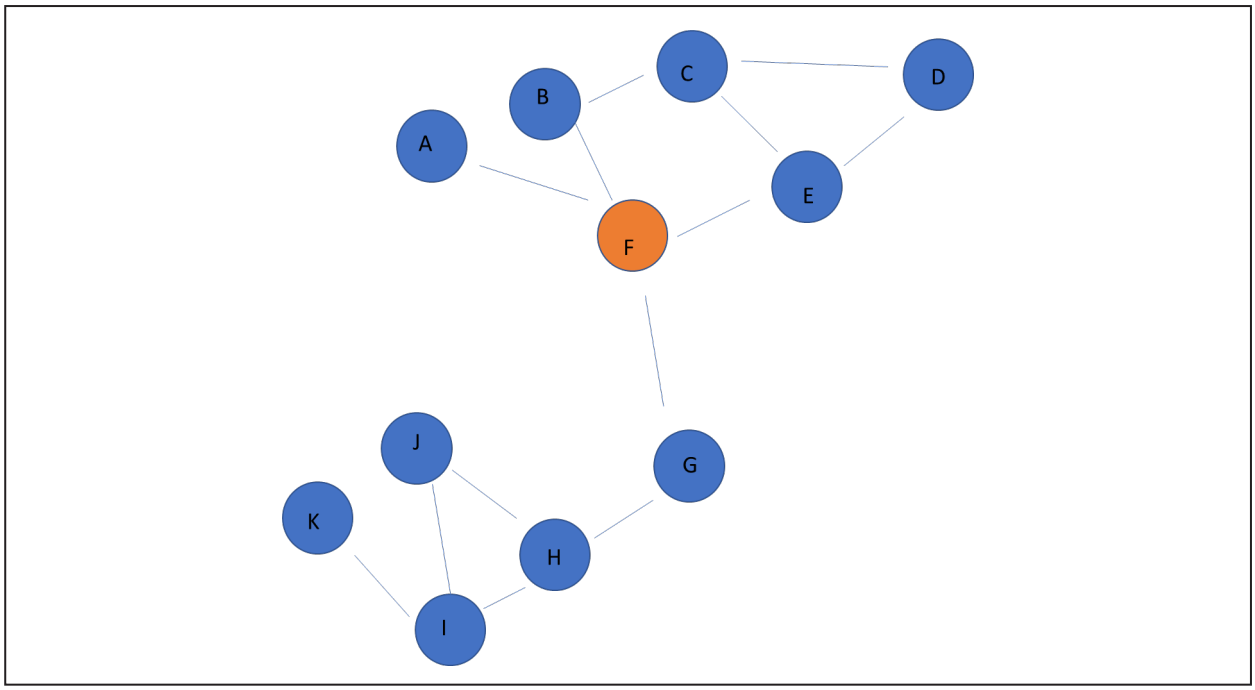

Figure 11. *Illustration of betweenness centrality*

To do so, there is a table indicating all the possible pairs of Nodes and if the shortest path between them includes Node F or not.

Table 2. *Possible pairs of nodes reaching NodeF*

Node from	Node to	includes F?
A	B	0
A	C	0
...		
A	I	1
A	J	1
...		
B	I	1
....		
...		
I	K	0

The total number of shortest paths including Node F is 25 and 10 shorthest paths do not include Node F. So the number of betweenness centrality is 25 over 35, which is 0.71 for Node F.

Doing the same procedure for Node H, the betweenness centrality would be 0.4.

Even in such a simple model it is hard to do computation all the way long, as there is a high number of pairs even in case of eleven nodes.

In a lot of networks there may be a hundred shortest paths. Any network analysis tool will compute betweenness centrality of course.

To summarise it, betweenness centrality measures the degree to which a node is a gatekeeper in the network. So if information is spreading from these nodes over here to these nodes over here particular nodes are critically important if they stop participating in passing on information then no information flows through anymore.

So nodes with high betweenness centrality tend to be really important for connecting different groups and monitoring or helping the flow of information or diseases or other things through networks.

Connectivity measures

Moving on from centrality measures another way of understanding a network is how well connected it is. Connectivity and cohesion measure the minimum number of nodes to remove before the network becomes disconnected.

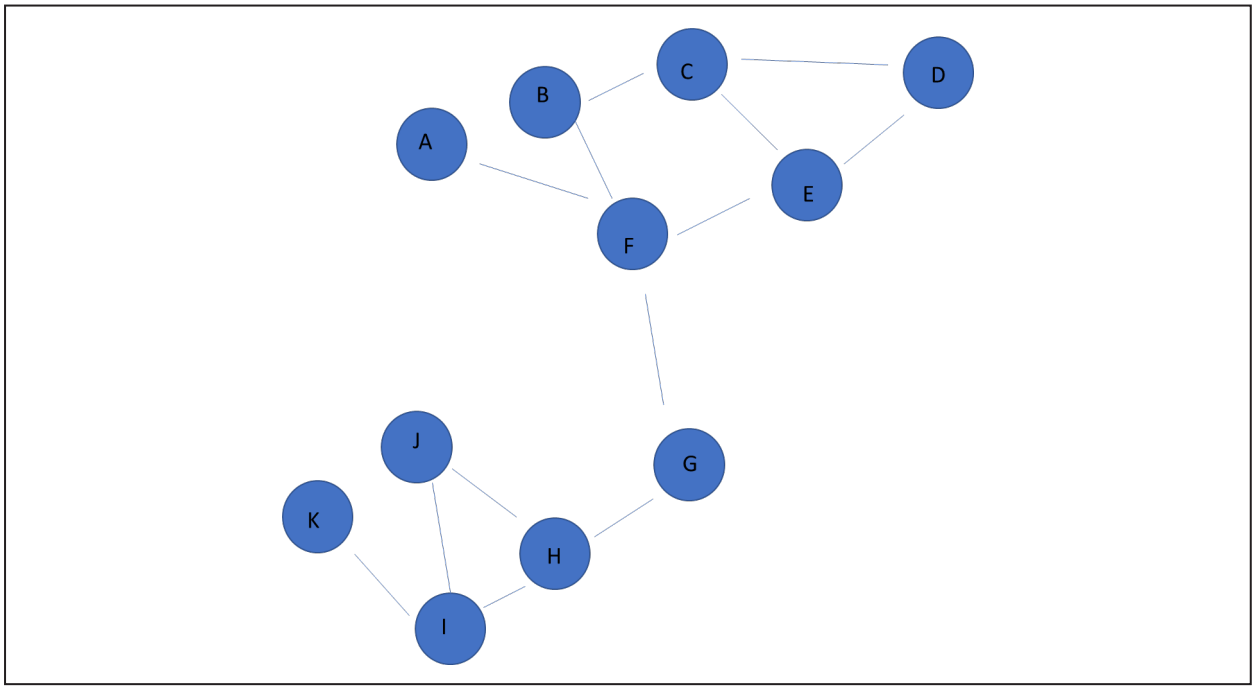

Figure 12. *Sample network for illustration of connectivity measures*

Removing either Node F or Node G the network gets disconnected. Therefore the connectivity measure for this particular network is 1.

Small worlds

In networks of social connections, the average distance to reach out to a specific node from an another one is quite small. Because of the existence of nodes with he number of inks (called as hubs), there are shortest paths going through these nodes that link further nodes. The term for such networks is small world. There is two major properties of small world.

One is that they have a *high average clustering coefficient.* In a small world network nodes' friends tend to know an another more than they would randomly. On the other hand, the *average shortest path length for the network tends to be very short.* That means that people who are in different social circles tend to have people that are connecting them to different groups. So we can get from one point in the network to another quite easily.

This is really interesting structural attribute. Most social networks, but neural networks, the power grids also tend to have this pattern.

Random graphs vs. regular graphs

Unlike in small worlds, random links between nodes form a random graph. The degree distribution follows normal curve. The complement of a random graph is a regular graph.

Random graphs are something that were studied extensively by Paul Erdos who we mentioned in the original presentation in terms of the Erdos number.

He studied a lot of things with graph theory and random graphs and so this is an example of a random graph here. We have a bunch of nodes and you can see there's no real pattern to how the edges appear they're. The complement of a random graph is a regular graph. We can have a regular graph and a random graph with the same number of nodes and same number of edges like these two but they look very different.

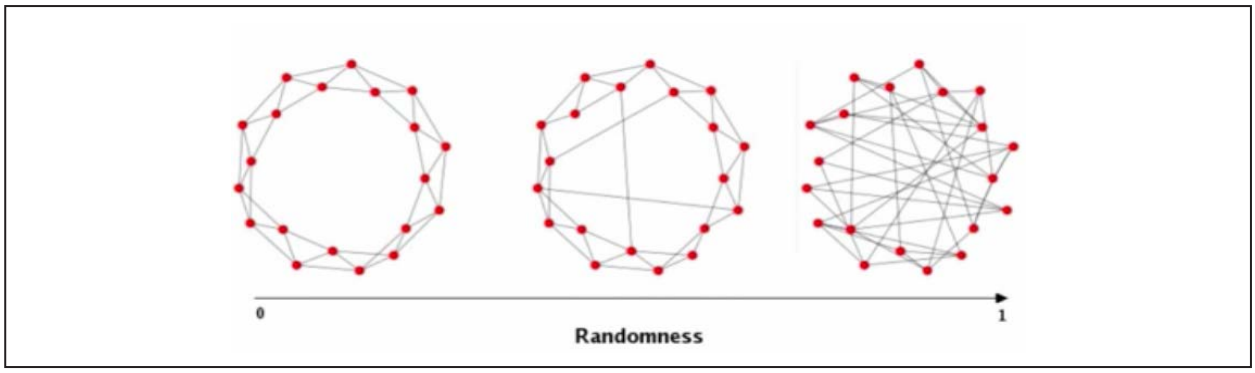

Figure 13. *Regular vs. random networks*

For a random graph the average shortest path length is very small. You can go from any node to any other pretty quickly because there's a lot of edges that cut across the network making it pretty quick to get from one place to another. So the average shortest path link for the network is short. On the other hand, for a regular graph the average shortest path length is long because if you want to get from a node at the bottom to a node at the top you basically need to go all the way around to get there. If the size triples, the average shortest path length also triples. That's not true for a random graph. On a random graph the size of the average shortest path length increases logarithmically with the size of the graph. On a regular graph it increases linearly. However, on a regular graph there's a generally high clustering coefficient. In a random graph the clustering coefficient tends to be very small.

By combining random and regular graphs' features small world networks can be generated that have both of these features. Removing few edges and rewiring them has very small impact on the clustering coefficient of each node overall. It may decrease it a little bit but not much. On the other hand, those edges that cut across the network makes average shortest path length dramatically smaller[4].

7.3 Networks of agrifood chains

A supply-chain network (SCN) is an evolution of the basic supply chain. Due to rapid technological advancement, organisations with a basic supply chain can develop this chain into a more complex structure involving a higher level of interdependence and connectivity between more organisations, this constitutes a supply-chain network[5].

Often organisations focus only on their organisation; what they produce or provide and not what the end customer receives. Looking at a supply chain network enables firms to look at the overall movement of materials/information from start to end, allowing organisations to see the value in creating partnerships; and the value in working together to ensure the best possible value is provided to the end-customer.

Supply chains and supply networks both describe the flow and movement of materials & information, by linking organisations together to serve the end-customer[6].

Let's look at a supply chain example model in apple juice production.

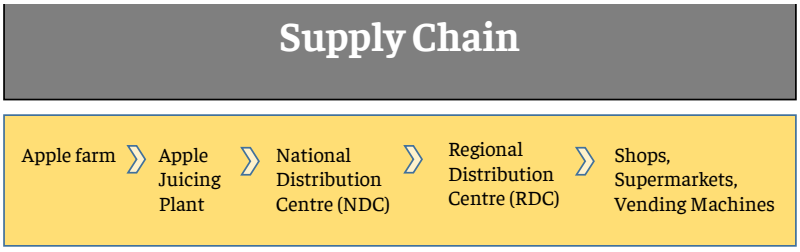

Figure 14. *Supply Chain Example: for apple juice production*
Source: Hinz[6]

In the above example of an apple juice producer, the flow of materials is seen as a chain of supply from farm to end users.

The apple farm provides fruits for juice production, which entering the distribution chain goes through the regional – local levels of logistics. In the end the juice arrives in shops or to other retailers.

The above diagram is an example of a simplified supply chain. The extended supply chain however includes not only the movement of material flow from the Apple farm through the production process to the end users, but the flow of further materials used in the production. Which pictures the inbound chain of production.

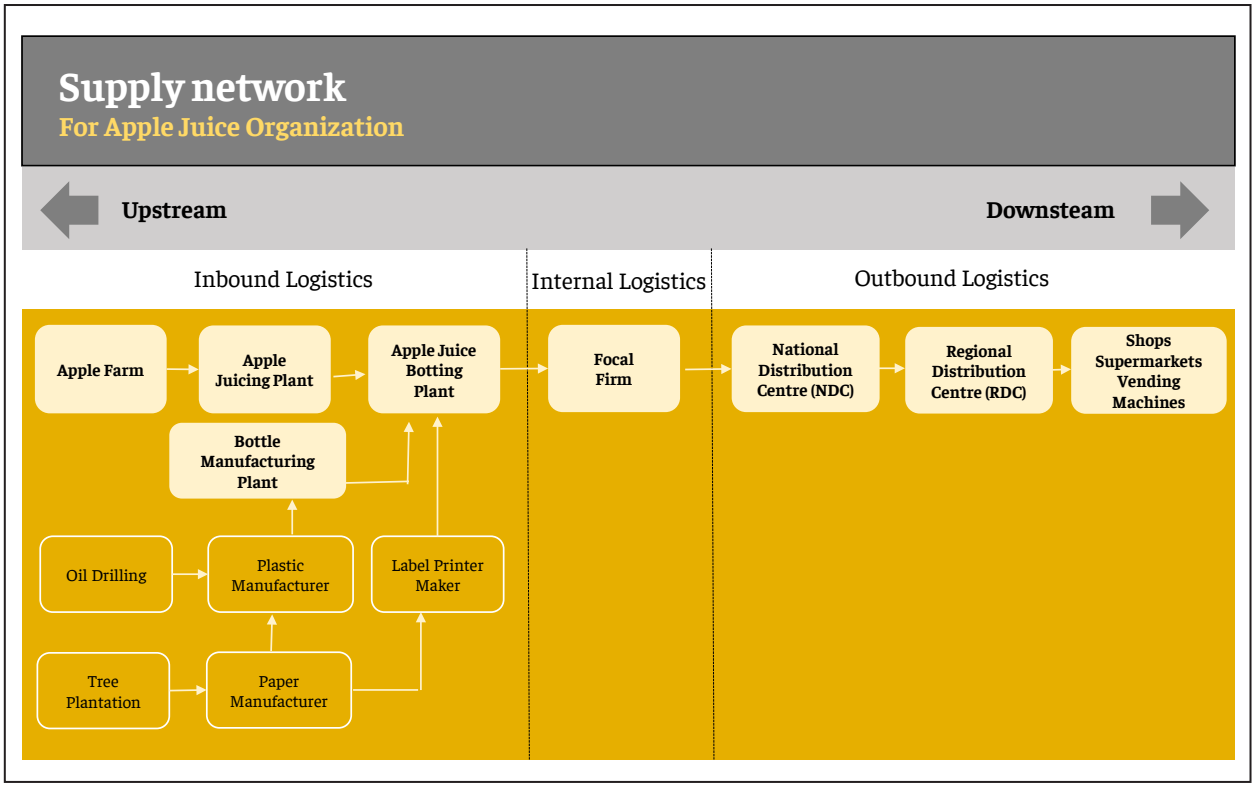

Figure 15. *Extended Supply Chain Example for apple juice production*
Source: Hinz[6]

To get a complete picture of an organisations supply chain network, however, both information and material flows should be mapped. Inefficiency can then be located and removed.

Material flow is the movement of goods from raw primary goods (such as Wool, Trees and Coal etc.) to complete goods (TV's, Radios and Computers) that are to be delivered to the final customer.

Information flow is the demand from the end-customer to preceding organisations in the network. If a focal firm provides their suppliers with their sales data/forecasting demand information; their supplier will be able to reduces costs (such as over production waste) and improve prices. In order to better serve your end customers, it can be important to develop strong partnerships within your supply network which has an effect on flow to end customers, irrespective if being manufacturer, distributor or retailer. Better communication will increase efficiency and productivity. Trust is the core ingredient to develop better communication and relationships.

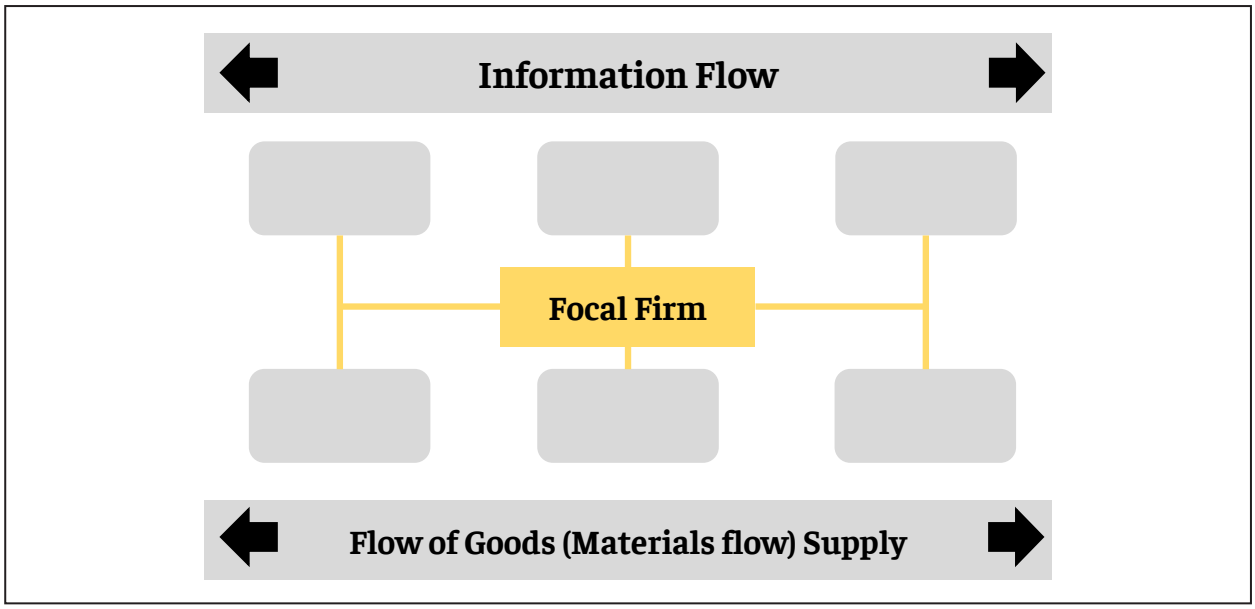

Figure 16. *Information flow vs. material flow simplified model*
Source: Hinz[6]

7.3.1 Case study, presentation of good practice

The following subchapter introduces a model of network of an agricultural producer and service provider company. The idea of seeing the company sales and purchases of a given timeframe in a network provides a new perspective of analysing which products, services, partners, etc. are more vulnerable or valuable for the company. It helps them understanding patterns which enable for example better pricing or better relations management; in general better efficency of the operations.

The overall structure of the company's sales and purchases covers quite a few tables on their products, services, partners, invoices, details of invoices, etc. The data are retrived from the annual accounting records in the period 2007 to 2021.

Table 3. *Elements of data records*

invoice number n = 3228
partner code n = 86
city of partner n = 32
date of financial performance (dd.mm.yyyy) 2007–2021
number of items: 72
number of partners: 6
units of measure
amount of unit
price per unit (HUF)
gross sum of item (HUF)

The network of sales in this company may refer to nodes such as item types, partner codes, or sub items, while the links between the nodes can be defined by the city (in common to the partners), the year of performance (in common to the invoices), or items (in common to the invoices or partners). From these aspects, a possible network can be the nodes of partners (codes), with links representing the city in common, so those partners are linked, who are seated in the same city. The partners (nodes) degree depends on the number of

partners seated in the same city. By tallying up the number of partners with various number of degree gives the degree distribution.

In the following example the edges link products and serices (items) that are present in the same invoice, in this way the „streght" of the link (value) represents the number of invoices where these items are jointly listed.

Another representation may be the link (az edges) between invoices (as nodes), when the same item (product or service) is listed in both invoices. In this way the value of the link refers to the number of items the invoices are in common.

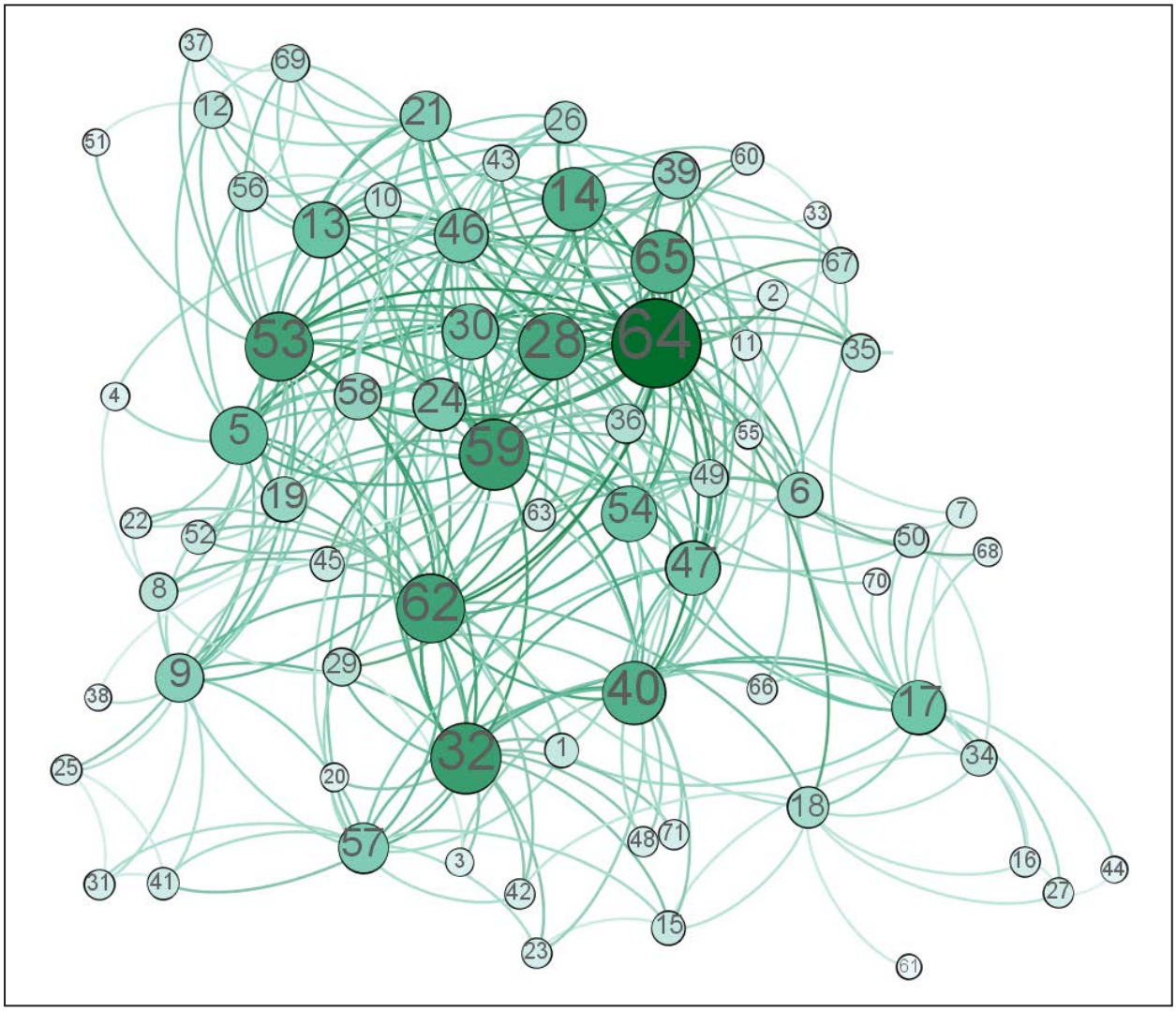

Figure 17. *Network representation of the sample farm's invoices*

In the above network of invoices (Figure 16) there are nodes (products or services) that are listed in many invoices, the highest numbers are 64, 62 and 59. Whilest, some of the items (nodes) are more unique, having only 1, 2 or 4 invoices in common.

Understanding the nature of the network might give an insight on which products or services can be offered as a package by the company, or which of them are individual offers.

Let's introduce the information on the partners. For this purpose, the network illustration is changed and the different colours of edges show those links that belong to different partners.

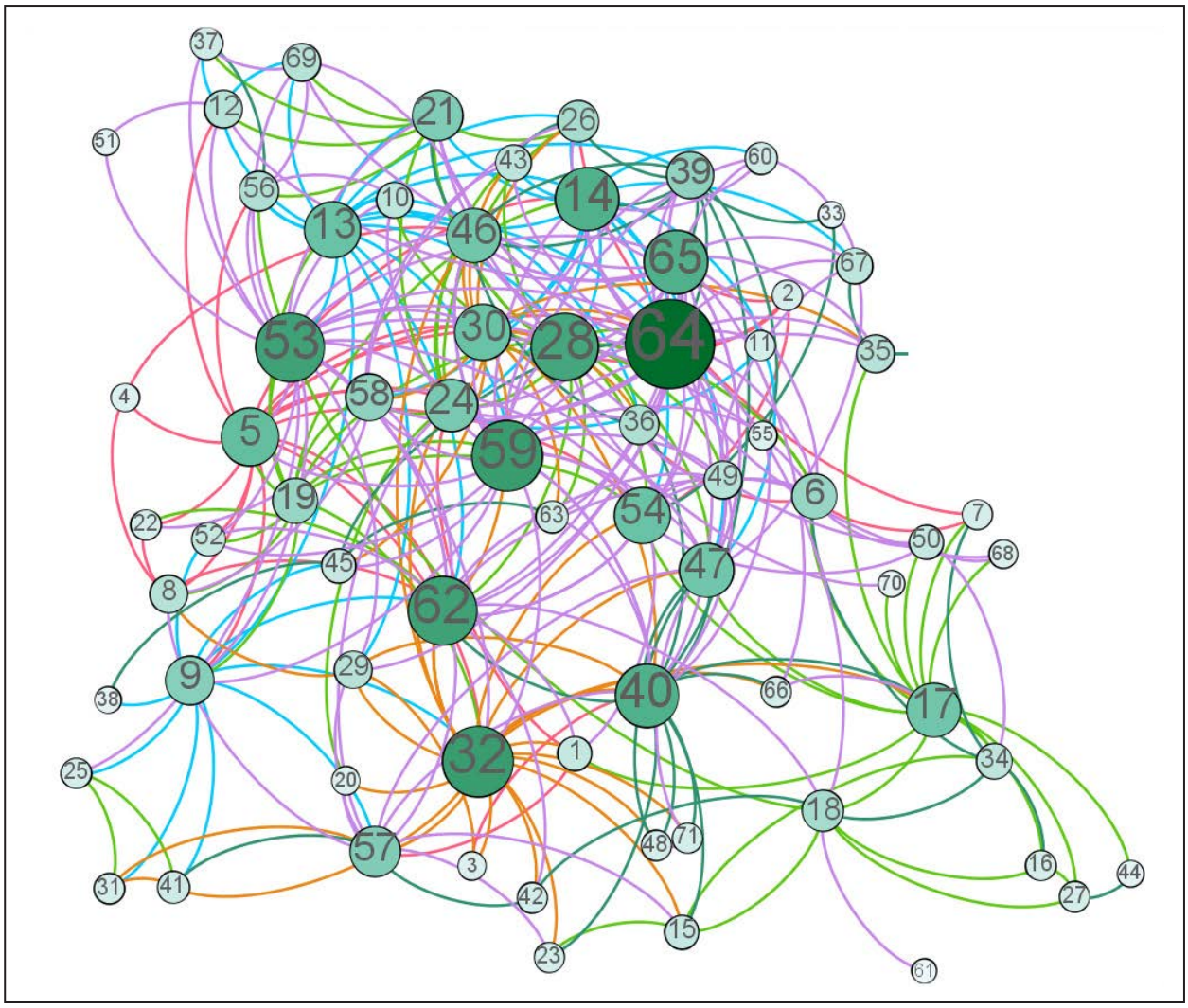

Figure 18. *The farm's partnership structure on invoices and items*

The sample network of the farm' sales invoices illustrates the six partners with differnt colours. By understanding the nature of the network gives information on the differentiation strategy of relations management.

A deeper look at various measures and statitics of the network adds even more details for managers.

Bibliography

[1] Molnár L. (2020) A hálózatelemzés alapfogalmai – gráfok, centralitás, szomszédosság, hidak és a kis világ In: Sasvári, Péter (szerk.) Rendszerelmélet. Ludovika Egyetemi Kiadó Nonprofit Kft. – Ludovika Press, Budapest. pp. 123–140., https://doi.org/10.36250/00734.07

[2] Barabási A. L., Posfai M. (2016) A hálózatok tudománya, Libri Kiadó, Budapest.

[3] Harrrison, A., van Hoek, R. (2011) Logistics Management and Strategy, 3th edition, FT Prentice Hall, Harlow.

[4] Barabási A. L. (2022) Behálózva - A hálózatok új tudománya, Open Books, Budapest.

[5] Slack, N, Chambers S. Harland, C., Harrison, A. and Johnston, R. (1997) Operations Management, Fifth Edition, FT Prentice Hall, Harlow.

[6] Hinz, P. (2011): What is a Supply Chain Network? https://www.adaptalift.com.au/blog/2011-09-27-what-is-a-supply-chain-network Letöltés dátuma: 2021. 11. 12.

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CHAPTER 8

Strategic management of food products

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8.1 The basics of strategic management

„Without a strategy, an organization is like a ship without a rudder and going round and round." (Joel Ross and Michael Kami)

With the onset of the Fourth Industrial Revolution and the changing development dynamics of products and markets, operational excellence has become more critical than ever for any organization. In a world where development is the constant driver of progress, strategic management has a distinguished role. "Continuous external and internal environmental effects, the growth and transformation of organizations all contribute to the development of the strategy of organizational transformation and change."[1] Strategic management provides a basis for managing these changes. Strategic management deals with the formulation and implementation of managerial decisions, the purpose of which is to create sustainable competitive advantages.

8.1.1 Operational and strategic management

The strategy of long-term value creation (e.g. a better, cheaper or faster offer than that of competitors) is a key condition for long-term competitiveness. Yet, we do not have generally accepted measures of value creation, such as are commonly used and accepted to define value. "Value" is an elusive and multidimensional concept that varies widely over time, place and the customers, users or stakeholders involved.

Strategy is the basis for the effective and long-term operation of any organization. The creation and application of strategy goes beyond simply "operating on the basis of experience." The correct strategy maintains the continuity and security of the company's operations and ensures that the possibility of errors is minimized.

Verdin & Tackx disagree with the statement that the more competitive the business, the less it needs to focus on competition[2]. Strategic success is determined by the ability to continuously innovate and create added value for the customer. This will determine whether we will be able to "beat the competition" in the process".

The strategy is a specific way of thinking, a form of behavior, a specific problem management tool that forces the management of the organization to deal with the solution of important/non-urgent issues before

a possible crisis situation arises. Strategy is a harmony-creating activity. It is necessary to know the challenges of the environment, the expectations of the owners and the resources of the company, and to create harmony between them.

It is a proven fact that the crisis of most organizations can be traced back to incomplete or faulty management, which is why it is important that this is properly set up. On the basis of types, we can distinguish operational management, where the day-to-day operations of the company and its management take place, and strategic management, where long-term decisions are made.

Three levels of strategy can be identified: the company level, the strategic business unit level and the functional level, which differ in several aspects.

Markó[3] writes based on Marosán[4] that operative management deals with the continuous operation of the company. Its problems are either temporally, territorially, organizationally, or functionally delimited. He cares about issues that – "no matter how painful" – never threaten the existence of the organization as a whole. On the other hand, the challenges of strategic management – even if they seem to be postponed at a given moment – take effect in the long term, affect the organization as a whole, and are directly related to the survival of the organization.

The table below shows the difference between the two types of management:

Table 1. *Differences between strategic and operational management*

Strategic management	Operational management
Complex situations, unique solution methods	Routinely manageable, clear decision-making situation, frequently used decision-making models
Decisions that affect the organization as a whole and are of fundamental importance	Decisions affecting parts of the organization and specific isolated functions
Long-term effects and consequences	Short-term effects and consequences

Source: Marosan[4]

8.1.2 Pillars and processes of strategic management

Strategic management processes are practically grouped around five main tasks:

1. Defining the strategic vision and the mission and developing them.
2. Setting goals.
3. Developing a strategy in order to achieve the goals successfully.
4. Implementation and execution of the strategy.
5. Evaluation, continuous monitoring[5].

Problem solving requires a strategic analysis in order to get a realistic picture of the company's situation. The internal and external conditions must be assessed and planned, how they can be restored. It is necessary to prepare a plan, which must include where the business is headed.

The strategy is formed during a rational decision-making process. Three stages of the decision can be distinguished: the analysis, the choice/decision between the options and the implementation/execution. The starting point of the process is the appearance of a problem affecting the organization. In reality, the steps of analysis, decision and execution often overlap.

As a result of the circumstances, it may happen that a decision has to be made before all the decision variants have been explored (and this is especially typical in agriculture), and since the strategic position is constantly analyzed during the implementation, a new decision situation may arise based on this. In general, the creation of a strategy consists of stages built on each other, which most companies go through step by step. Each section can be broken down into further sub-tasks (Figure 1). The management steps and sequence are of course the same in the field of agribusiness.

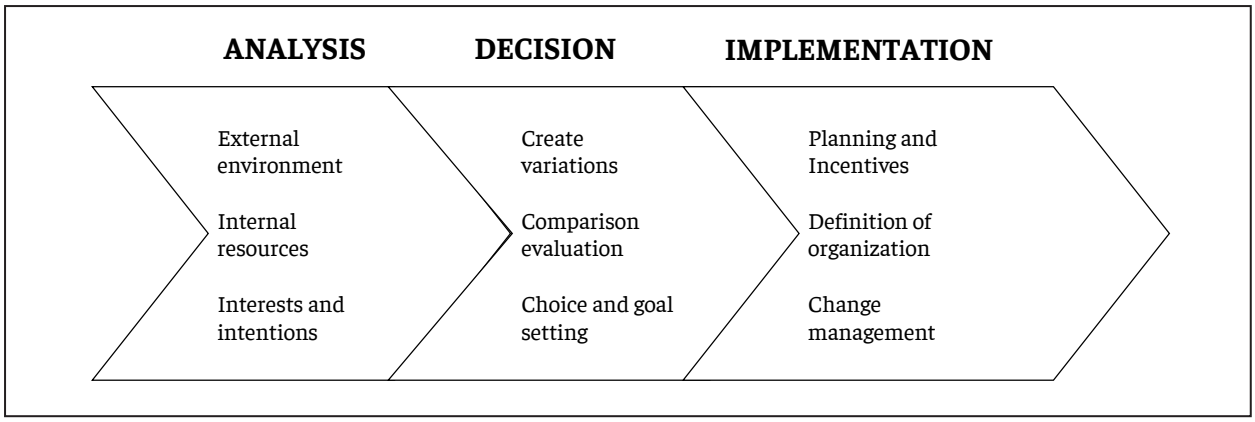

Figure 1. *The simplified process of strategic management*
Source: Marosán[4]

In the course of the analysis, the organization's external environment, internal resources, and the interests influencing its efforts must be connected to each other, as a result of which the organization's strategic situation can be revealed, which contains many opportunities and threats.

The first step of a strategic decision is the creation of decision variants, the second step is the comparison and consideration of these variants, and finally the decision itself is the last step. In the past, the decision stage was only considered a formality and no deeper analysis was done, but nowadays it is seen as a complicated process accompanied by conflicts of interests within the organization. Taking into account the interests of the groups influencing the decision is an important factor.

In the implementation phase, the implementation of the selected strategy is institutionalized. The first task is to create the organizational conditions for the strategy, which mostly includes strategic planning as well as the appropriate distribution of the resources necessary for implementation. The next task is to develop the organizational form and culture. Finally, in this stage, the implementation control system is created, as well as the management of changes.

8.2 Organizational culture

8.2.1 The company's core values, mission, vision, and the Golden Circle

The main goal of the strategy is value creation. It defines the possibilities (value creation), is related to the implementation (value configuration) and the end result is profit, as the benefit of value expenditure.

Regarding the strategy, the first step is to develop the strategy (mission, values, vision, strategic analysis). This is followed by planning (strategic map, measures, goals), organization "in order" (business, support units, employees), organization of operations (development of key processes, sales planning, budget). This is followed by the process of monitoring and learning (strategic and operational reviews) and testing and adaptation (profitability analysis, strategic relationships, emerging strategies).

Management typically develops its strategy based on five main tasks[6]:

1. Developing a strategic vision and mission is the first step – Where are we going? Why were we created? What are our core values?
2. Setting goals.
3. Developing a strategy to meet the objectives.
4. Strategy implementation and execution.
5. Monitoring, evaluation and corrective measures [7].

Before formulating a strategy, managers must agree on the company's purpose (mission), the internal compass that guides its activities (values), and the pursuit of future results (vision). An organization's mission and values tend to remain stable over time. While vision is not as stable as mission and values, it is often

constant throughout an organization's three- to five-year strategic vision. A company's values (often called core values) dictate its attitude, behavior and character. For example, the Euralis seed distributor, which has been serving European producers with corn, sunflower, sorghum, soybean, and rapeseed seeds for more than 60 years, "We create value and trust!" he tries to summarize the values behind his strategy with his slogen[1]. The Bonafarm group, involved in plant cultivation, feed production and livestock breeding, does the same with the labels "Passion and expertise", "Old passions, new values", "Everything that is fresh"[2].

All strategic work must begin with a description of core values. We can return to them at any time if we experience a blockage in the business process. Core values always help you find the right answers.

A mission statement is a short statement (usually one or two sentences) that defines why the organization exists. The mission should describe the fundamental purpose of the organization, especially what it provides to customers. A mission statement should inform managers and employees of the general purpose for which they have come together. "The business mission is therefore nothing more than an organization's (company/sector's) basic statement regarding its values and expectations." [8]

It states that the organization:

- what (what basic activity)
- why (for what social goal, future vision)
- for whom (which target group)
- how (through which projects, services, with which methods)
- where (in what geographical scope) it operates[6].

For example, John Deere declares: "At Deere, we have always believed in business activities that promote life. Whether it's road paving or tree planting, we shape the spaces that sustain us. We turn raw materials into machines that create a chain of livelihoods - from supplier to trader, from our customers to their consumers, from us to our community. For the sake of productivity, profitability, and the planet, we build our innovations not on finding problems, but on revolutionary solutions that make every life better in the only world we know. With the dignity with which we are worthy of the Deere name, we live with nature, carefully operate our factories and support the people who trust us and the planet that sustains us. Working together to design and delight, test and educate, outperform and overcome difficulties to make life even better."[3]

The vision defines the medium- and long-term (three to ten years) goals of the organization. It should be market-oriented and expressive – often interpreted as a vision. A statement that provides a clear, specific aspiration.

„The vision is therefore the definition of a target state that constantly shows the direction to be followed for all those involved in the implementation of the strategy. The target state must be fixed at all levels of the strategy, regardless of whether it is the implementation of a company, a settlement or region, a country or an international strategy"[9]. On the basis of all this, creating a vision of the future is also a choice of direction, as it expresses the values, activity and risk-taking ability of its creators. With its help, you can focus on change, innovation, the development of organizational capabilities, the continuation of strategic activities, and generally staying competitive.

The organizational strategy must be renewed at least annually. At the meeting, the team reviews and confirms the company's mission, values and vision. Analyzes external and internal information and summarizes critical strategic issues in a SWOT analysis. If the management sees that significant strategic and cultural changes are needed in the coming years, it clarifies the need for change through strategic change, which can be communicated throughout the organization. If the existing strategy continues to work effectively, the team may decide to change it only gradually.

The leader definitely has a significant role in how the given decision will be made, what the basic goal will be, and what the core values will be. According to SINEK the best leaders think according to a so-called "golden circle" method[10]. The golden circle concept takes its name from the golden ratio, a simple math-

[1] euralis.hu, 2021

[2] bonafarmcsoport.hu, 2021

[3] deere.hu, 2021

ematical relationship that often appeared in nature and art, and was used by mathematicians, architects, and artists even at the beginning of history. The golden circle method helps us understand why we do what we do, and also shows how much more we can achieve if we ask the question "Why" before every activity we start. It's all about "Why?" starts with a question.

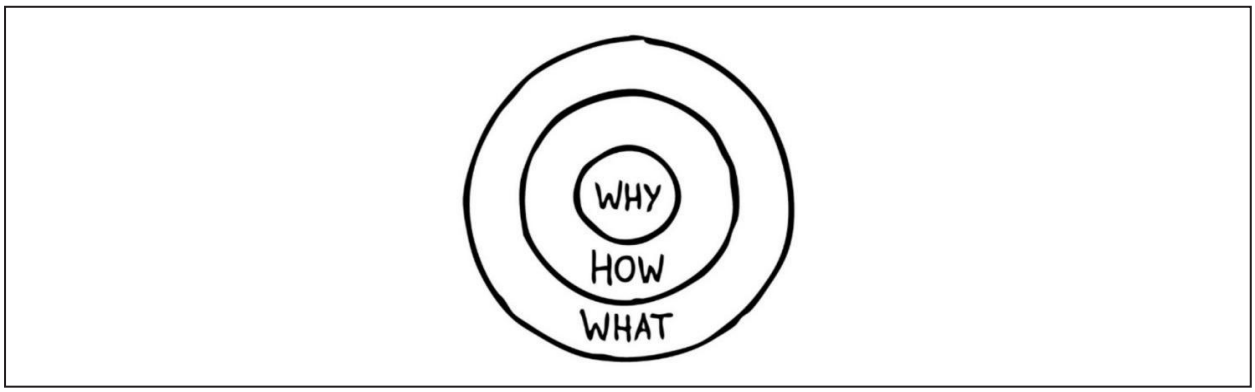

Figure 2. *The golden circle*
Source: Sinek[10]

WHAT: The management of each company probably knows what it does (what product, service it offers). This is true in all cases, regardless of the size of the given company and the industry. All organizations can easily define what they do and describe their products and services in detail. The „What?" based on these, it is easy to answer the question.

HOW: Some companies and people know "how" to work on the "What?" with a question. The "how" typically gives a precise description of why or in what way the given product or service is better compared to competitors on the market. What makes it unique? Difficulties may arise here for some organizations.

WHY: In the end, very few organizations and top managers articulate clearly why they actually do what they do. When we look for the answer to "why", we search for why do I get up in the morning and do everything to make the business successful? Why is this important to me as a manager or employee? Therefore, "for money or for results" is an incorrect answer. When in most organizations they start with the "what" and then close the strategic planning with the "why": they rarely answer the question "why" we do what we do[11]. On the other hand, those managers who are able to motivate their employees at a high level always give the answer to "why" first and will be number one committed to making the "cause" a success.

8.2.2 The relationship between values and organizational culture

Values and culture determine what strategy a company considers or rejects. A fundamental statement that a company should not take strategic actions that conflict with its culture and/or guiding values widely held by its leaders and employees.

The formation and implementation of a culture that enhances the competitiveness of a company requires systems approach, understanding, intuition, ability to combine, calculations, judgment and communication skills from the top management. The management must create the culture of the company, its coordinated components and system, as a result of the "discussion" with the division strategy. Culture, unlike "hard" factors such as buildings or external elements of image, is difficult to copy. This is especially true when looking at international markets.

Corporate culture is a special immaterial resource: a system of values that is present in the company's organization, operation, management, and material and non-material output, and the more it is integrated into these, the more significantly it can increase the competitiveness of the organization and its operations. The corporate culture must be integrated into the entire system: starting with the formulation of the company's mission and concluding with the definition of the basic elements of the customer relationship.

A better understanding of organizational culture is illustrated with some models in the following.

8.3 Organizational culture models

8.3.1 Iceberg model

The classic model of Edward T. Hall[12] compares the organizational culture to an iceberg (Figure 3), the part above the water is clearly visible and can be easily examined with the naked eye, while the parts below the water lie unnoticed in the depths. Newcomers can cling to the tip of the iceberg, but they can only learn about the hidden, invisible characteristics during interactions with old members and during a longer time spent in the organization.

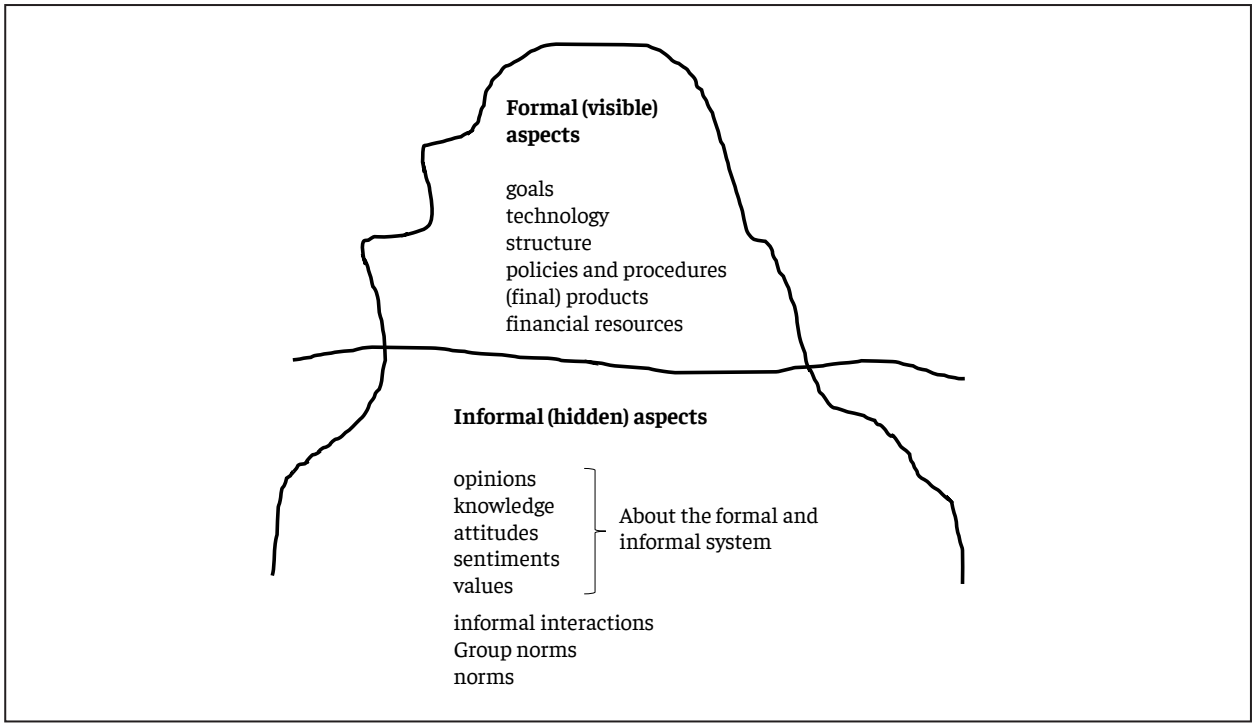

Figure 3. *Iceberg concept illustration*
Source: French and Bell[13]

If we ignore the hidden characteristics of culture, we make a serious mistake, as we did then, because we are not aware of the unexplored piece of the iceberg. If we stay on the surface, of course we are constantly faced with "symptoms", but we can never understand what lies behind them, what are the real root causes, the essential driving forces. "Real organizational culture can be seen in the values, assumptions, beliefs, feelings and attitudes"[14]. John Deere, for example, adheres to these values: honesty, loyalty to the roots, leading technical solutions, always staying green.

8.3.2 Cameron-Quinn model

Based on Bakacsi[15] the model (Figure 4) takes a closer look at what values organizations strive to increase their efficiency by taking into account. He identifies two such values based on research:

Inward or outward focus: when the organization focuses on the efficiency of processes and members or on the fit with the environment (and its needs).

Flexibility or tight control: we can observe greater freedom of movement and greater freedom of decision based on discretion or tight control and more regulation of the behavior of the members in the organization.

The two dimensions form a four-quadrant matrix, and each quadrant shows the types of organizational culture.

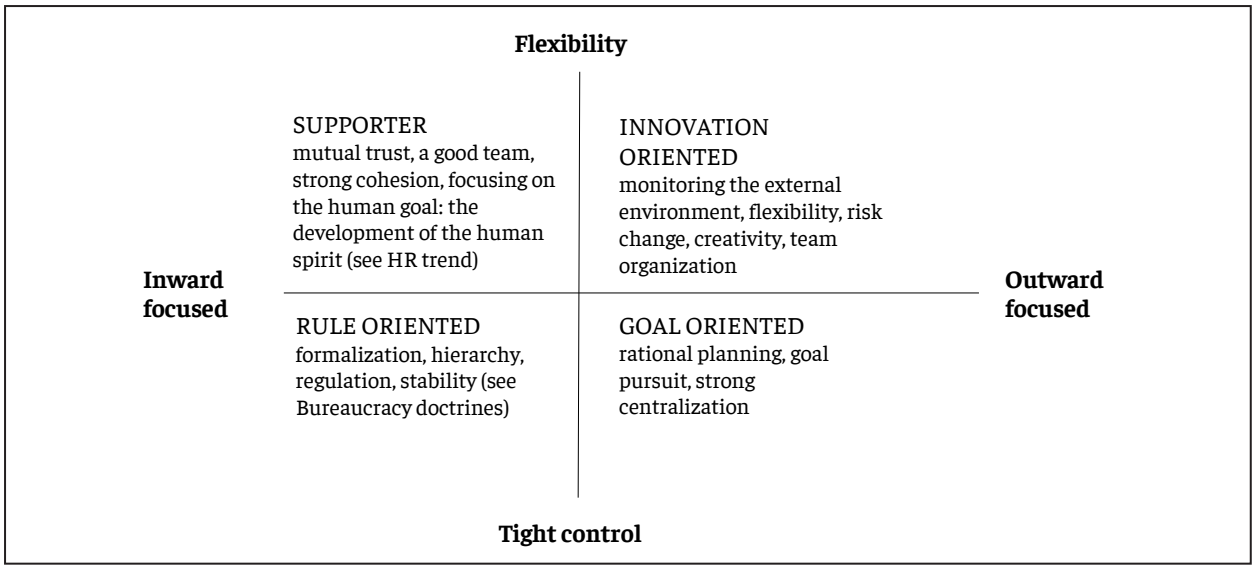

Figure 4. *Elements of the Cameron-Quinn model*
Source: Cameron and Quinn[16]

Supportive culture: characterized by mutual trust and responsibility, joint participation, cooperative behavior among members, good team spirit, strong cohesion, individual development, and the realization of self-fulfillment. In addition, the sufficiency and acceptance of informal and mainly oral communication, commitment to the organization. Its central value is the development of human resources (e.g. through training, coaching, and the use of coaching). For management, employees are more important than environmental challenges.

Rule-oriented culture: its characteristics are respect for formal positions, rationality of processes, regulation, strong division of labor and formalization. In such companies, hierarchical organizational solutions, written communication (often based on instructions and subsequent announcements of "we made this decision"), and the complexity of decision-making (slow turnaround) come to the fore. Its central value is stability and balance, communication serves this, and decisions are based on this. For management, the most important thing is to preserve the results achieved up to that point. Its background in organizational theory: bureaucracy theories focusing on internal processes, as well as organizational culture, which is also common in agriculture.

Goal-oriented culture: its characteristics are rational planning, central goal setting, efficiency, expectation and respect for high performance, the central role of managers, oral communication tied to tasks. Its central value: productivity, efficiency, profit. Management focuses primarily on achieving goals. Typically, top-listed companies operating in a highly competitive environment can be found here.

Innovation-oriented culture: characterized by increased monitoring of the external environment, risk-taking experimentation, creative problem-solving, competitive spirit, future orientation, foresight. In addition, the free flow of organizational information, working in teams, creating task groups, constant training and learning. Its central value: growth and acquisition of environmental resources, flexibility, constant readiness. Management focuses on exploring and seizing opportunities.[17]

The role of culture is essential in terms of management processes. It decisively determines the values along which the mission and vision are built, and at the same time designates the toolkit for strategic planning, implementation and control as well.

8.4 Competition and strategy

The first step in planning the strategy (Figure 5) is the analysis of external and internal conditions. This can be followed by the formulation of strategic goals. As a final stage, the tools and methods for implementation are assigned to the goals. We analyze the organization's external environment, study the position of competi-

tors, and identify our future partners. We examine our resources (material, human, technological, innovation, etc.) and capabilities. Continuous and conscious analysis of the external environment is essential in order to timely assess the opportunities and threats that can improve or worsen the organization's performance.

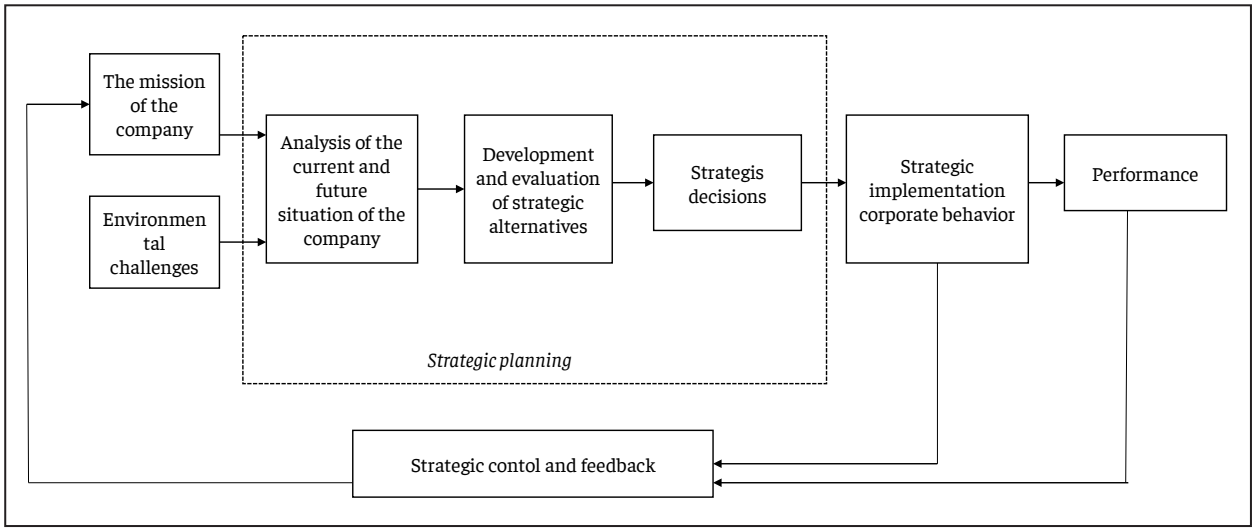

Figure 5. *The design model of strategy creation*
Source: Tóth[18]

In planning, the establishment of long-term strategic goals is the primary priority, without them the survival of the organization is quite doubtful. The long term means a period of 2-5 years.

The strategy is basically created to make the company competitive and to maintain and/or increase its competitive advantage. In order to improve our competitiveness. P. Drucker recommends following actively the next information[19]:

- The unexpected external event, success, failure,
- contradiction between plans and reality,
- The needs of the processes of use,
- changes in the structure of the industry or the market,
- demographic changes,
- the transformation of consumers' attitudes and
- new knowledge, either scientific or non-scientific.

The competitive strategy is usually modified in the following main dimensions[20]:

- Specialization takes place.
- Brand recognition is in focus.
- They increase the quantity/quality of indirect and direct advertising.
- A sales form is chosen/changed.
- They change the quality of the product.
- They strive for technological leadership.
- Vertical integration is initiated
- Cost position is improved.
- Customer service is being improved.
- They use a price policy.
- There is a change in ownership influence.
- The quality of the relationship with the parent company changes.
- The relationship with one's own and the host government changes.

In the field of agriculture, Fleet, Fleet & Seperich identified eight factors that influence strategy and make this field special[21]:

1. The product is food, with all its special characteristics.
2. The biological nature of agriculture (e.g. weather, pests, diseases, weeds, pregnancy cycle, climatic determination of wine grapes).
3. Seasonal nature of the business.
4. The uncertainty of the weather.
5. There is a huge variety between the types of agricultural, food and food industry enterprises.
6. Diversity of market conditions: cotton growers present an almost textbook case of perfect competition in a market where individual sellers have almost no influence on price. At the same time, Coca-Cola and PepsiCo have a literal duopoly on the soft drinks market. Some markets are global, others are local. Some markets are characterized by an almost equal bargaining position between the buyer and the seller, while in others a dramatic imbalance may develop in favor of one or the other player.
7. Close connection with the countryside: many agricultural enterprises are located in small towns and rural areas, thus playing a very important role in the economic development of the countryside.
8. The role of the government is of particular importance (e.g. price regulation, income regulation, health protection, use of plant protection products, animal waste management, customs duties and quotas, etc.)

8.4.1 The process of strategic planning with hierarchical levels

Strategic planning can be based on the three hierarchical levels:

1. Company-level strategy,
2. Division strategy (about market and product) and
3. Functional strategy (about processes, resources).

David et al. describe that when measuring performance, the payment of bonuses at the company-level strategy is 75% based on long-term goals and only 25% on short-term goals, while at the functional level this ratio is the exact opposite: 75%. At the level of the divisions, this ratio is approximately 50-50%[22].

Based on Mező et al.[23], Porter distinguished three basic types of company-lrvel strategy basic strategies by analyzing the possibilities of creating and maintaining a competitive advantage (Figure 6).

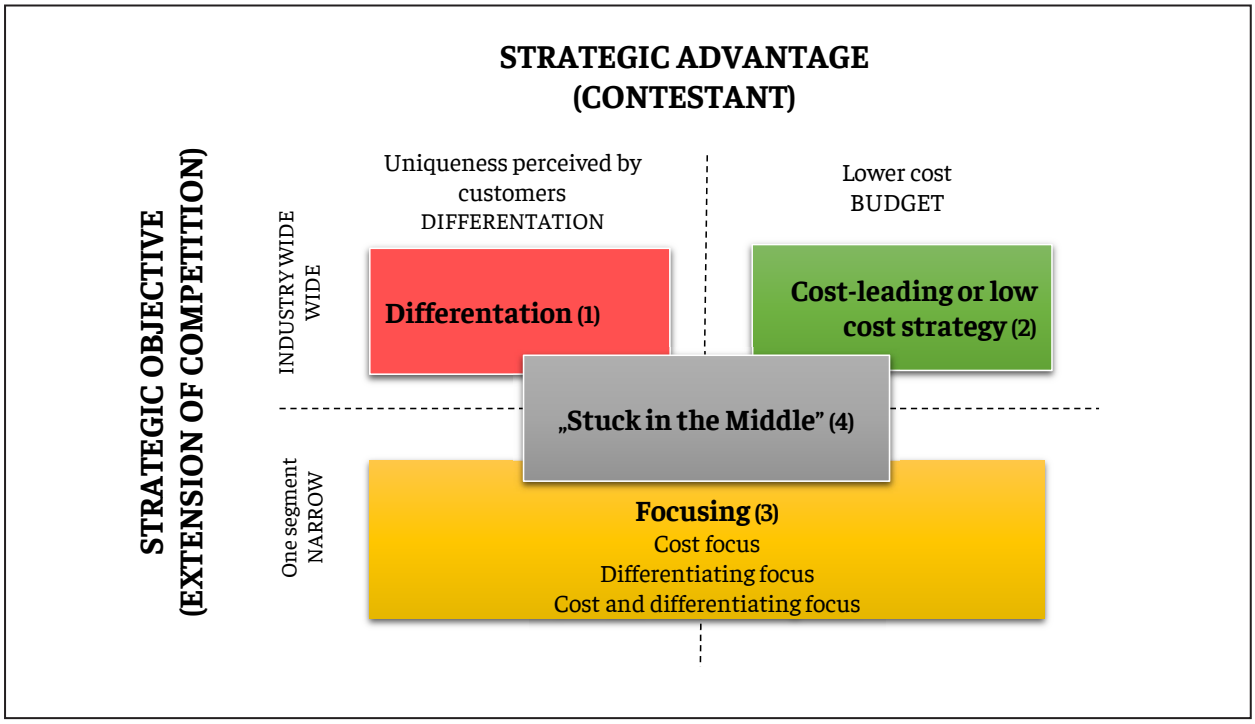

Figure 6. *Porter's basic strategies according to competitive space and competitive advantage*
Source: Lőre[24]

A company may have industry-wide competitive advantages that enable it to pursue a cost-controlling (cost-leading) strategy. For example, in the case of pocket calculators, the number of competitors was radically reduced in the 1970s, so Texas Instruments was able to offer its products at more advantageous prices than its competitors, and established a price-controlling position. Taking an example from today, the general strategy of Hyundai and KIA can typically be classified here.

In this case, the company's goal is to surpass the competition by reducing costs. Although every company tries to control its own costs, the cost manager has an extreme advantage in this regard, since he makes all the decisions about products, markets and special capabilities. The cost-leading company usually focuses on narrow product differentiation.

It only develops products when consumers specifically demand them, in which case the goal is not to lose the market. The cost leader usually focuses on the average consumer, and the most important special ability lies in the production function, where he strives for perfection (which can further reduce costs). Its most important danger is precisely that the competitor invents a production method that can be operated at a lower cost.

Many companies gain a competitive advantage in uniqueness, building on differentiation rather than excelling in mass production and cost reduction (differentiation strategy). For example, in the case of Coca-Cola, the soft drink vending machine was a new, unique distribution channel at the time, which had a distinctive advantage. The most important aspect in this case is to achieve a competitive advantage by creating a product or service that the consumer considers special and extraordinary. Such brands are, for example, BMW, Audi, Mercedes, Volvo, Mazda in the automotive industry, Tebike Pálpusztai cheese from agriculture and the dairy industry, or Garabonciás hand-kneaded Parenyica cheese, and in general, domestic foods with the "Hungaricum" certification.

The company typically wants to achieve differentiation through branding, better technology, better service, and thorough knowledge of the selected segments. It spreads the products more widely, just like the cost planning company, although in many cases this causes difficulties at the start (e.g. getting listed in a larger supermarket chain).

The strength of the concentrating (concentrating, focusing or specialization) strategy lies in the fact that they target one market segment and satisfy its needs to the fullest extent possible. In this case, there are at least two approaches[25]:

Low-cost approach – in this case, you compete with the cost leader in those segments where you have a local cost advantage (e.g. you get a better price on transportation or production costs). From 2004, the pivotal point of the strategy of Suzuki in general, but also of the Suzuki Swift (1983-) in particular, is clearly the low-cost production (China, Hungary, Pakistan, Malaysia, Thailand, Vietnam) and the affordable price, the small car (small-class popular car) segment getting and keeping first place. In addition, the need for differentiation quickly became apparent in several areas of development.

Differentiating attitude – these organizations are usually successful in perfecting the characteristics of the differentiated product because they know small groups of customers or a certain region intimately (e.g. Subaru, Land Rover, or Liszt Rapsódia artisan chocolate from Dombóvár, or Lolo snack products from Kaposvár, from the food industry, which are vegan, oil-free and additive-free products).

The competitive advantage of a specialized company lies in its core competence. It finds opportunities in market niches, which it fills with products and services without which consumers cannot exist. A specialized company focuses on serving the market segment defined by the territory, customer category or part of the product line. You are protected from your competitors to the extent that you can provide a product or service that they cannot. These companies are mainly threatened by the sudden disappearance of the segment due to an innovation change or a change in consumer tastes and interests.

Porter claims that these strategies are almost always suitable for creating a competitive advantage, regardless of the specific market situation. He recommends that a company focus on developing and implementing only one dominant generic strategy because differentiation and low cost cancel out each other. A company that wants to combine these will be stuck between opposing strategies and will not be efficient.

Organizations can choose from 11 different strategies (Table 2).

Table 2. *Strategic alternatives at different hierarchical levels*

The essence of strategy	The name of the strategy	Its characteristics
Vertical integration	Forward integration	Gaining ownership or control at a distributor
	Backward integration	Gaining control and ownership at a supplier
	Horizontal integration	Gaining control and ownership at a competitor
Intensive growth	Market entry	To increase the market share of an existing product in an existing market through marketing
	Market development	Distribute an existing product/service in a new geographic region
	Product development	Increase market share by further developing existing products, modifying them or creating new ones
Diversification (Offer Expansion)	Joint diversification	Acquisition of an existing, related product or service
	Independent diversification	Launching a completely new, unrelated product or service
Defense	Constraint	Reorganization, cost reduction, sale of properties
	Disconnection	Selling a division or unit
	Liquidation	Selling the entire company piece by piece

Source: David et al.[22] based on own editing

Most companies run 2-3 strategic alternatives in parallel, but in the long term this so-called combination strategy is very risky. Many of the organizations involved in the food sector have successfully integrated forward or backward into the vertical, as well as some member companies of the previously mentioned Bonafarm group, but a recent example is that Spar Magyarország Kereskedelmi Kft. acquired the manufactory of Zimbo Perbál Húsipari Termelő Kft., thereby adding new meat producers acquired interest (backward integration).

The main suggestion is to select the top priority, as resources are limited. This sustainability is especially true in the era of the green economy. In the words of the authors, "if you're heading north, the plan is to get snowshoes and a warm jacket and forget about trying to generate rapid consumer growth in the southern states." At the same time, the three defensive strategies can be operated side by side, complementing each other. For large, complex organizations, such as Mondelez and Unilever also operate several strategies side by side, since different divisions can operate according to different strategies. In a fiercely competitive situation, it is a matter of survival to maintain positions and, if possible, to further improve them. This usually requires choosing a growth strategy. It is important to note that the strategy, which is purely aimed at market expansion/growth, and the company is not a "green" company, its product/service is not useful from a sustainability point of view, nowadays in developed countries it receives more and more criticism from experts and scientists.

If the management decides on a growth strategy, it can choose from the following options (Table 3).

Table 3. *Growth strategies*

Strategies	Advantages	Disadvantages
Organic growth (the company develops new activities internally)	• Lower risk • The possibility of continuous learning • More controllable	• Slow • Lack of necessary knowledge – wrong decision
Acquisition	• Fast • Presence, purchase of market share • Buys experience	• There is a high price to pay • High risk of wrong decision • The right company is not always available • It is difficult to get rid of unnecessary wealth
Strategic alliance (agreement between two companies)	• Cheaper than pickup • Access to market knowledge • Useful if the acquisition is not favorable	• Possibility of control difficulties • Potential driving problems
Joint venture (joint venture) (independent enterprise jointly founded and owned by two companies)	• As with the strategic alliance, plus • Better incentive, closer connection • Other competitors are better excluded	• As with the strategic alliance

Source: Barakonyi[26]

For a strategic alliance, David et al. cite the example of Apple and IBM[22]. While in the 1980s the two companies acted as competitors on the market, today they jointly manage the development of more than 100 applications. With this collaboration, Apple quickly expanded in the business world, which was traditionally IBM's market, and IBM was able to successfully sell its business software on the mobile device market.

More than 10,000 joint ventures are registered every year, more than the total number of acquisitions and mergers we are aware of, the author duo writes. IBM cooperates with the Twitter and Facebook organizations, as the large amount of meaningful user data (Twitter alone registers more than 300 million monthly active users) gives its partners the opportunity to developnew so-called "social data-enabled" programs.

In addition to the strategies summarized above, being the first to enter a given market/segment, ahead of your competitors, can be a valuable competitive advantage. Outsourcing is also a popular strategy. After 2010, European and American companies in many cases outsource production, technical service or "back-office" activities, leaving only research and development in-house. During the prime ministership of Donald Trump, an effort was launched to resettle production in the mother country ("Made in the USA" program). Predictability of wages, lower gas and electricity costs, legal protection, stronger control over quality and distribution, strong economy, lower transport costs, greater respect for human rights, stable political system speak in favor of resettlement.

8.4.2 Factors influencing the strategy

The industry situation decisively determines the initial competitive strategy. Let's take a closer look, what does this mean?

In divided industries (e.g. monopolistic market conditions), the following areas come under the magnifier:

- What is the structure of the industry and what is the position of the competitors?
- Why is the industry divided, what is the reason?
- Can the division be overcome, and if so, how?
- Can bridging the division be profitable?
- How should we choose the market position of our company in order to make this step?
- If division is inevitable, what is the best alternative to deal with it and operate more profitably?

These questions must be answered in emerging and rising industries:

- Is our company a founder or a follower? Do we dictate, do we have the know-how/patent?
- Are raw material sources secured? And the sales channels? Who are the suppliers? What kind of reserves does the supplier base have? How can this range be strengthened?
- Are entrants closely monitored? Can we set entry limits?
- Coordination of product development and customer needs is essential.

If we compete in mature industries, companies are concerned with the following aspects:

- "The changes accompanying the transition to maturity hold serious dangers."
- Increasing discipline in the organization is an important task.
- Expectations regarding advancement must be moderated.
- Greater attention should be paid to human factors.
- The need for recentralization may arise.

In declining industries, strategic focuses change:

- The goal may be to preserve the leading role.
- We can stay in the industry to fill a market gap, serving the needs of "lagging" and loyal customers.
- Harvesting, collecting the profit that can still be realized with gradual downsizing.
- Rapid capital withdrawal and switching can also be the new strategy.[27, 28, 29]

It is customary to compare strategies with certain stages of the life cycle model, since strategy and strategic actions are both easy to understand and separate from each other.

The life cycle model starts from the assumption that industries, companies and products all go through a development process that lasts from market introduction to decline. The development process has 5 stages (in the classical interpretation only 4, since the breakthrough stage is not named):

- introduction,
- (breakthrough),
- growth,
- maturity,
- decline.

We examine the brief characterization of each stage in a marketing strategy approach. A different strategy and tactic is focused on for each stage. These are included in Figure 7.

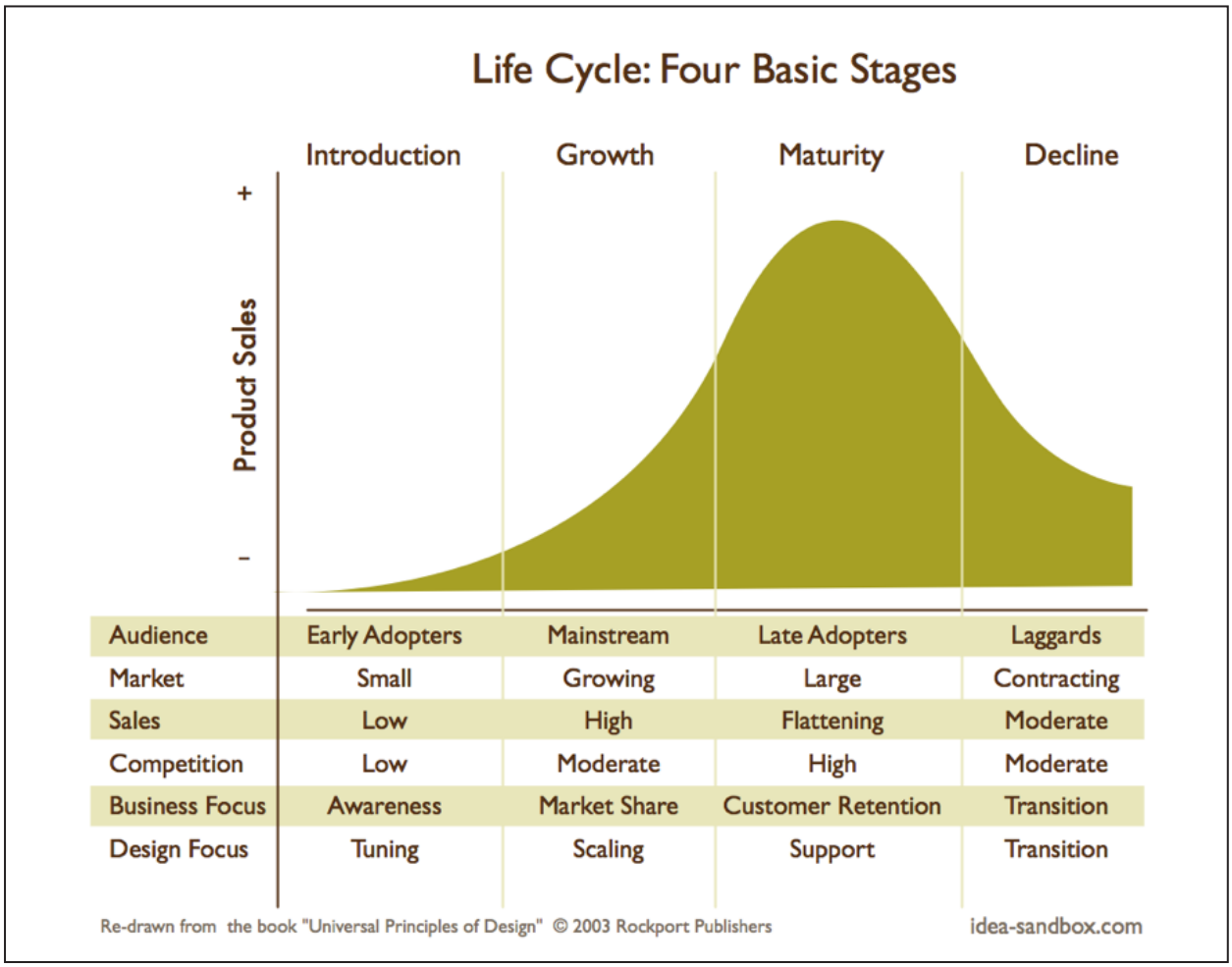

Figure 7. *Marketing strategies at different stages of the product life cycle*
Source: https://acarrascoblog.wordpress.com/marketing-concepts/product-life-cycle-stages-and-strategies/

In the case of technologies, it is easy to follow the case of life cycles running in parallel (Figure 8): in our example, the fourth generation phones are already in the maturity stage, but meanwhile the 3G phones have already reached a declining phase. Today, 5G technology is in the introduction phase, well before the breakthrough phase, while the previous two technologies are still on the market.

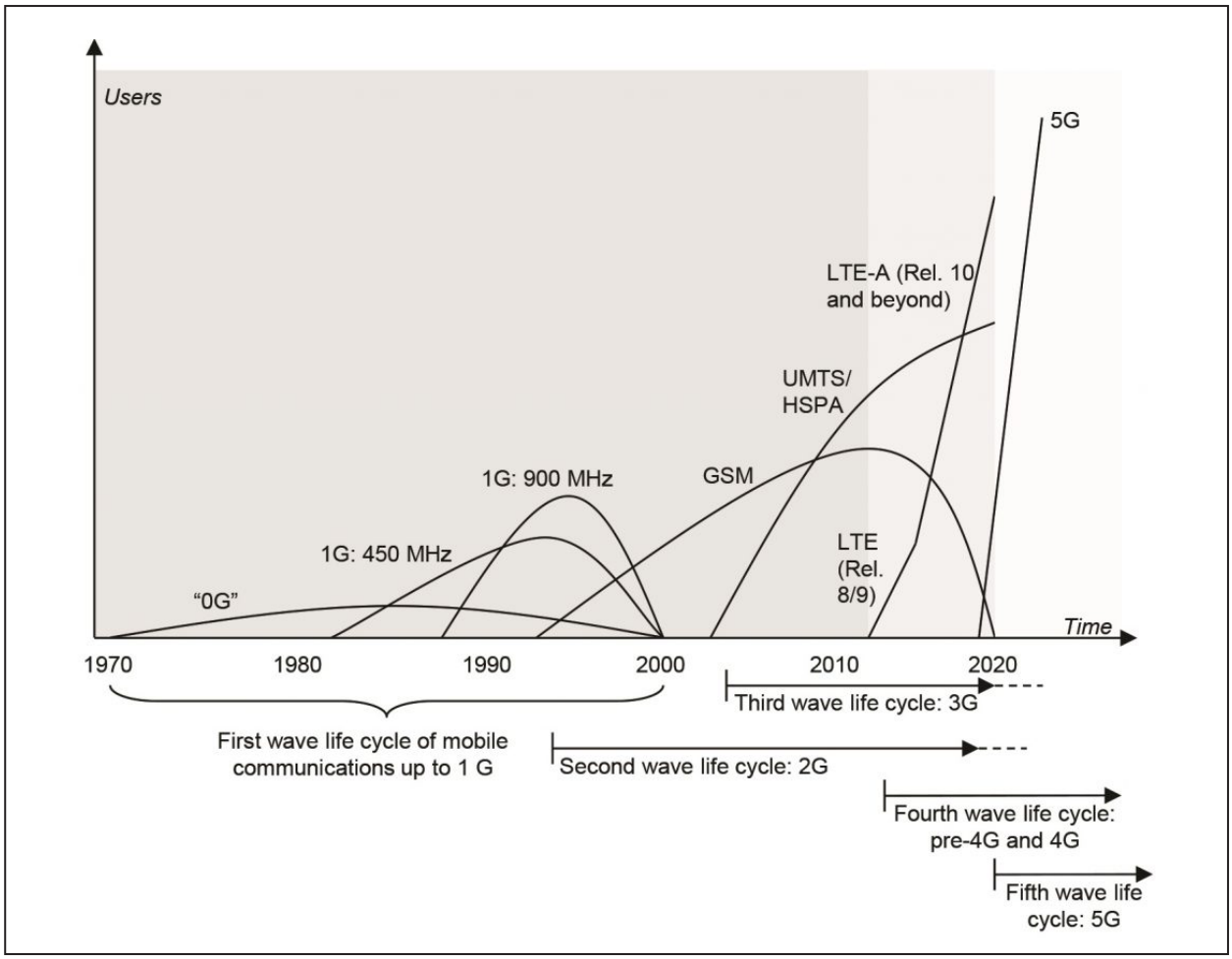

Figure 8. *Coexistence of life cycles for technologies: from 1G to 5G*
Source: https://interferencetechnology.com/mobile-generations-explained/ (2019.08.07.)

In some cases, life cycles follow a path different from the general one, and the development of the life cycle can have a significant influence on the corporate strategy.

8.5 About internal and external resources

Every organization has strengths and weaknesses in each functional area. It is advisable to analyze these areas regularly so that the processes work with the best efficiency. If we accept that the company strives to satisfy customer needs and create maximum value, then this internal audit can also be interpreted as an audit of value-creating processes.

8.5.1 Value chain model and 5 force model

The processes are vividly summarized by Porter's value chain. According to his concept, a company is able to operate effectively if it is aware of the importance of its key processes and can devote its resources to increasing the value of its products and services.

Chikán writes that the company's value chain consists of a series of activities that use resources to produce recognized value for the consumer[30]. Thus, the important question is not how the company evaluates the production process, but how the consumer evaluates it. A process group will be effective when the needs of consumers are satisfied, as consumers are then willing to pay a price for it that covers the company's costs and generates a profit.

Dobák states that the value is when the consumer not only buys the product or service, but also the process itself, which produces these products and services for them[31].

Today, we can make the following additional statements:

- The analysis, identification and development of activities that really create value have become a defining element of the corporate strategy.
- It is considered the most important issue of the strategy: deciding where to place our company within the industry value chain.
- It has become vital to understand and accept: what value does the beneficiary really require?
- Thorough knowledge of the industry and the company's value chain is indispensable.
- The real strategic question is where the organization positions itself in the global industry value chain.
- The main value-generating activity is the service, and the "foreground" (where the customer is served) increases in value compared to the "background", which the customer has no real insight into and typically does not seek to get to know it deeply [32].

The company mobilizes resources to create value. Resources are usually divided in the following way[32]:

- financial resources,
- physical resources,
- human resources,
- technological resources,
- intellectual resources,
- fame, recognition.

David et al. recommend taking stock and analyzing the following in the internal audit process[22]:

- managers' and employees' assessment of the situation of organizational culture, internal values and other components;
- management processes (especially organization, incentives and controlling),
- marketing,
- financial affairs,
- production,
- research and development,
- the management information system.

The analysis of the value chain is used to determine to what extent and how the individual functions, activities and the resources behind them contribute to the company's value creation, as well as to the company's competitive position and the implementation of the corporate strategy[33] The elements that provide the most important competitive advantages (how resources are used) are also called core competencies.

These are the following:

– added value
– cost effectiveness
– relationship management
– uniqueness

core competencies

Porter distinguishes nine value-creating activities from each other (Figure 9): primary (creating value) and supporting (not directly generating value) activities. according to him, these can be considered the key processes of a company, the efficiency of which can be measured with continuous performance-cost analyses. decomposing company processes into strategically important factors can help to make it clear where and what costs are generated.

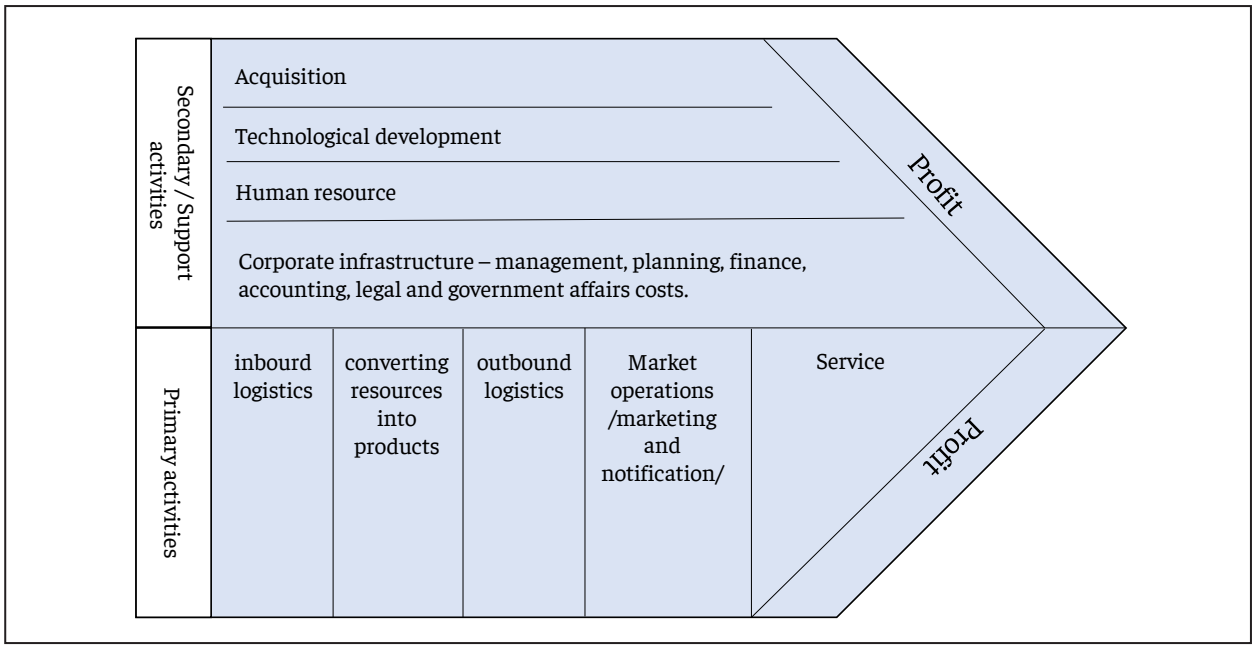

Figure 9. *Porter's value chanchain model*
Score: Keller and Kotler(2012) edited by Benedek[34]

Kiss summarizes that the activities that affect materials, semi-finished products and other inputs arriving at the company are called internal (inbound) logistics[35]. During the transformation activity, outputs are created from the incoming inputs. In addition to production, this also includes product or service packaging and quality control. The objective of outbound logistics is to deliver the product/service produced by the company to customers in the right time, quantity and quality. According to PORTER, marketing and sales are responsible, among other things, for introducing potential customers to the products offered and generating sales. He highlighted the services as an independent element and placed the after-sales contact with the customers, the areas of warranty, complaint, and sales front here.

The corporate infrastructure may include, for example, the planning, control, decision-making system, the communication and information system, the organizational culture, and cost management.

Human resource management is also a complex process, for example recruitment, selection, training, incentives are all areas that belong here.

K+F functions, the effort to develop new products, new services, further development of technologies, and process management systems appear in the technological block. To gain a competitive advantage, this is a key process element. Procurement is the group of activities that provides the inputs needed to perform the primary activities.

In several graphs, the margin (profit margin, profit) is placed at the "top" of the value chain. Based on Dankó: "The measure of the performance achieved by the company's value chain is the margin (the surplus that the consumer is willing to pay in addition to the product's production costs). This shows how well the company's "machine" works, how effectively it has been seen the previously outlined functions, and how well coordinated the relationship between them was."[36]

Modifications can be made after the analysis. For example, in the case of the production strategy, we can decide whether to outsource production or introduce a new product, perhaps change location, change the type of production process, or make a technological investment, possibly pushing for automation.

In relation to the key management processes of agribusiness, Fleet, Fleet & Seperich highlight the importance of finance, the distribution channel, marketing management and HR[21]. In the agricultural sector, the quality and quantity variability of products remains a significant challenge in the management of value creation processes. Processors, canners and freezers of lobster and shrimp, for example, must consider and differentiate between different quality raw materials. Apples and other fruits are typically sorted by size, shape and color using infrared light. Eggs and milk need to be classified, like many other products. In some cases, the weight of the products must be standardized. An additional difficulty in the production of agri-

cultural products is the requirement of price efficiency. Production managers must produce outputs at the lowest possible price. It is necessary to produce the highest possible value in accordance with the production costs. A milk processor e.g. can rightly say that cheese has a higher market value than liquid milk intended for table consumption; but if the value is only one-third more than that of milk and requires twice as much production costs, then the price efficiency is not adequate, for this reason it is preferred to produce simple liquid milk[37].

8.5.2 Analysis of the competitors

The company and its real competitors form a specific, tight team, the so-called strategic group. They:

- in the same market segment,
- relying on the same competitive advantage,
- following a similar competitive strategy,
- with similar characteristics and
- having almost identical devices, they compete for the favors of consumers[32].

The purpose of competitor analysis is to estimate their expected future moves and how they are expected to respond to our moves. A detailed analysis of competitors is required to answer questions such as:

- Who should we compete with in the industry and what actions should we take?
- What is the meaning of our competitor's strategic move, how seriously should we take it?
- What areas should we avoid, where should we be concerned that our competitor's response will be strong?
- What are their goals? What is their strategy?
- In what direction are they changing?
- What skills and resources do they have?
- According to the customers' market value judgement, who and where is located in their minds?
- What are their strong key processes?
- What is their marketing communication based on, what is the unique product/service advantage they emphasize?

8.5.3 SWOT analysis

The development of the strategy is practically the result of a subjective decision based on objective data. Before choosing a strategy, it is absolutely recommended to carry out a SWOT analysis (Figure 10), which requires good judgment and thorough preparation from the organization. Based on this, four types of strategies can be selected, so-called "SO, WO, ST and WT" strategy[22]. The relationship between SWOT factors and selectable basic strategies is identified by Weihrich's TOWS matrix[38].

With SWOT, we can map the various markets, industries, businesses, and the tasks that are the most important for a company from a strategic point of view[39].

	THEY HELP achieve the goals	THEY PREVENT the achievement of goals
INTERNAL FACTORS (organizational characteristics)	**S**trengths	**W**eaknesses
EXTERNAL FACTORS (environmental characteristics)	**O**pportunities	**T**hreats

Figure 10. *The structure of the SWOT analysis*
Source: Pohner[40]

According to Pohner[40], Szőrös and Kresalek[41], and Czeglédi[39], strengths are the resources, abilities or other factors accumulated during the company's operation, which give it an advantage compared to its competitors. The resources of the organization are not only the factors that the owners have made available as monetary or physical capital, but also the factors that have already been exploited during the competition, as well as favorable positions that have been achieved by operating the capital. For example, a secure financial position, advanced, flexible technology and a well-qualified workforce, cost advantage, experience, know-how, new products, special services, organizational culture that supports development can be considered strengths.

Weaknesses are limitations or gaps in resources and capabilities that limit the company's performance compared to other organizations and make its market operations less and less effective. These factors can be the poor financial situation, low quality and outdated production units, outdated equipment, poor development. Even the same factors can be listed as weaknesses as strengths, depending on whether "compared to similar organizations, the examined organization is stronger or weaker in terms of the given factor"[39]. In the case of the Hart Cherry Cooperative, for example, the internal cohesion of the organization was greatly weakened, protracted internal disputes arose, even though they were faced with a simple problem. The farm was organized in 2012 with the aim of seeding and freezing the fruits of the member farms. Most of the cherries are picked from the trees mechanically, by shaking. Growers load the crop into palletized containers and transport it to the plant for processing. There are significant quality differences between the cherry shipments brought in by members, which is why it is important to be able to identify them.

Two years after the start, they were faced with the fact that the members could not be identified in all cases, as the truck drivers in several cases accidentally mixed up or left the identification cards posted on the containers. It is a simple case, but it took months to succeed with training or prevent disputes with increased control[37].

Opportunities are favorable external environmental factors beyond the control of the company that have a beneficial effect on its development. By taking advantage of these benefits, you can increase your customer satisfaction or even improve your return on capital. Such opportunities are, for example, the expanding market situation, the improvement of customer and supplier relations or falling inflation.

Hazards are also uncontrollable external environmental influences that have an adverse effect on the organization's current or future situation. Since these are more or less unexpected events, the company cannot prepare for them, so it is forced to adapt to them. Examples include rising inflation, the appearance of new competitors, the appearance of substitute products, changes in user needs, demographic changes, political uncertainty or unfavorable changes in state regulations.

The possible strategies (combinations) and the relationship between the SWOT factors are illustrated by Weihrich's TOWS matrix[38] (Figure 11).

Company	**Strengths -S** 1. Existing brand 2. Existing custumer data base 3. Existing sales	**Weaknesses – W** 1. Brand perception 2. Using intermediaries 3. Technology/ expertise 4. Cross sales channel support
Opportunities – O 1. Cross sales 2. New markets 3. New services 4. Alliances/ joint branding	**SO strategies** Utilization of strengths in order to maximize opportunities **Offensive strategy**	**WO strategies** Termination of weaknesses by utilizing opportunities Based on strenghts for offensive strategy
Threats – T 1. Consumer decision 2. New entrants 3. New competitive prod-ucts 4. Channel conflicts	**ST strategies** Utilization of strengths in order to minimize threats **Defensive strategy**	**WT strategies** Termination of weaknesses and threats Based on strenghts for defensive strategy

Figure 11. *The TOWS matrix and strategic options*
Source: Chaffey (2014) in Hajdú[42]

8.5.4 BCG matrix, GE-McKinsey matrix, positioning map

The BCG (Boston Consulting Group) matrix (Figure 12) is one of the most well-known portfolio methods for analyzing the microenvironment. It examines the products, product lines, services or business lines of a given company or division based on their relative market share and market growth. The basic purpose of preparing the BCG matrix[4][43]:

- to provide assistance for the market positioning of the company's products;
- determination of the strategy applicable to each product based on the examination of product positioning and product life cycles;
- creation of an optimal product portfolio from the company's point of view.

The BCG matrix divides products into four groups according to the aforementioned factors.

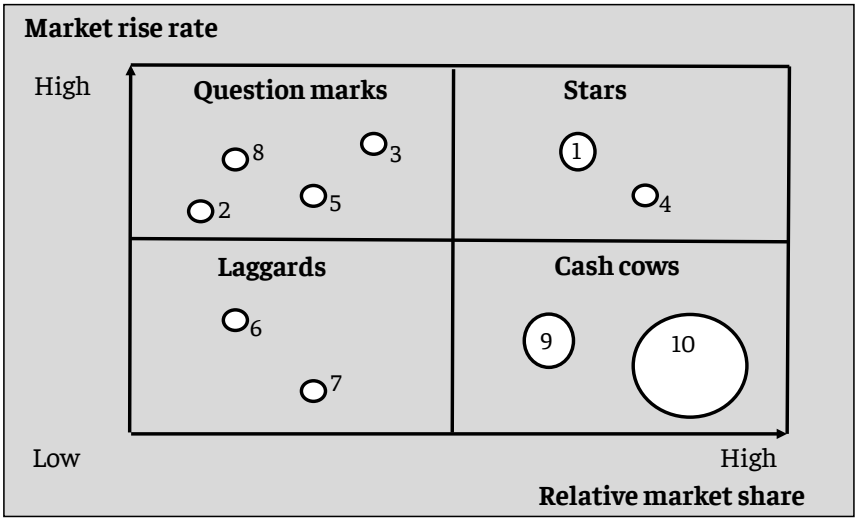

Figure 12. *elements of the BCG matrix*
Source: Gyurkó[44]

Stars are the products that occupy the best position in the target market and keep it stable. Their market share is outstanding and their growth is also high, i.e. the demand for them is strong. In the future, these products can become the primary source of company profit, so they must receive all the support: it is justified to expand production and support development, because they will be the "cash cows".

"Question marks" are typically relatively new products that still have a low market share, but show rapid market growth. It is therefore worthwhile to thoroughly analyze this type of product.

The market share of the products occupying the "cash cows" category is high, but the market rise has slowed down and is at a low level. The most important goal may be for these products to maintain their strong market position, and for the company to make full use of their potential. However, it is not worth starting new investments related to these products.

"Laggards or otherwise dogs" are those products for which neither the market share nor the market rise potential is satisfactory based on the results. Companies must stop making these products.

The General Electric-McKinsey matrix (Figure 13) was created as a further development of the previous method, providing greater flexibility and analysis accuracy. The model thinks in terms of competitiveness (competitive situation) and market attractiveness (environmental opportunities). The "upper right corner" is a safe zone and it is advisable to make additional investments here. The lower left corner is the danger zone, from which it is advisable to withdraw. The diagonal crossing the matrix (top-right bottom corner) is the "persistence" position, where you have to consider which strategy is expedient in the next period.

[4] HR Portál (2014) https://www.hrportal.hu/jelentese/bcg-matrix.html

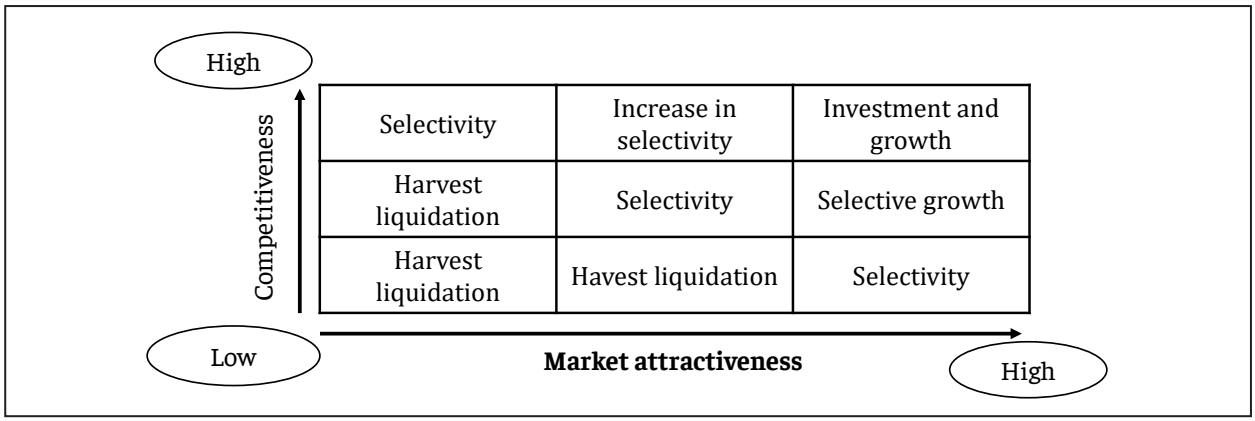

Figure 13. *Elements of the GE-McKinsey matrix*
Source: Varsányi[43]

Behind the competitiveness (competitive position) dimension can lie the evaluation of the following internal factors[32, 35]:

- market share compared to competitors,
- access to the determining competitive factors,
- profit ratio compared to competitors,
- the extent of additional services,
- effectiveness of communication,
- production efficiency,
- efficiency of K+F,
- sales network,
- product quality,
- popularity of the brand,
- development of the technology used,
- the quality of management.

A Market attractiveness (or long-term potential) depends on the following external factors:

- market size and rate of growth,
- the industry profit ratio (present and expected future),
- intensity of competition,
- inflationary tendency,
- technology and capital requirements,
- social and environmental constraints,
- market entry and exit restrictions.

All factors are rated on a scale of 1-5, at the level of business branches, and a different strategy is associated with the zones formed in this way. A result below 2.33 is considered a low value, and a value above 3.68 is considered high.

A strategy (perception) map is a two-dimensional representation that draws the companies/product categories/brands etc. its location along the two (freely chosen) most important components of the competition in the given industry. David et al. suggest that after we have designated the target segments (SZCP), we should deal with the compilation of this map[22].

The possible components are along the coordinate axes:

- degree of differentiation of the products/services,
- breadth of product selection,
- the number of market segments served,
- the distribution channels used,
- familiarity/frequency of use of the brand name,

- degree of marketing activity,
- the extent of vertical integration,
- product/service quality,
- innovation strategy (leader, follower),
- K+F capacities, role of research, etc.

With the help of the map, we can not only assess the situation, but also use it:
- We can determine the planned place of the given brand/product/service in the minds of consumers.
- We know which brands are close competitors and
- we can also be aware of what opportunities the market has for leapfrogging.

Figure 14 shows that, based on nutritional value and target group, soft drink categories can be perfectly placed on such a map. Group training offers ideas for modifying the product strategy.

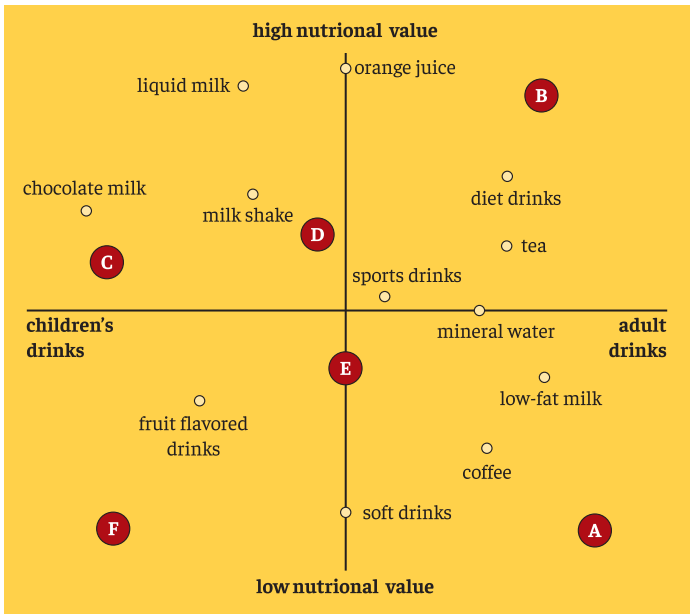

Figure 14. *Consumer perception of certain drinks based on nutritional value and target group*
Source: http://www.perceptualmaps.com/example-maps/ (2014) based on

Let's see, for example, how a seed company can develop its position. A lawn seed company markets its own seed families. The company's research department has completed the development of a new dwarf fescue variety. The variety suitable for lawns has performed very well in public cultivation. This variety produces a distinctive dark green color, dense, durable turf and is hardier than other varieties. The institute decided to try to build on these qualities and create a differentiated product that worths a higher price.

The residential market is characterized by two expected advantages: easy maintenance and environmental awareness. The position can be built on these two advantages. The variety does not grow as fast or as tall as other varieties. The fact that the homeowner spends less time mowing the lawn is an important factor. The variety also requires less fertilizer and water than other varieties, and due to the slow growth of the product, fewer cuttings need to be thrown away. This new product could be positioned as a lawn that provides more free time for environmentally conscious people[21].

8.5.5 Components for implementing the strategy

David et al. write that marketing, finance/accounting, research and development (R&D), and the management information system are the key areas for the operation of strategies[22]. The 7S model developed at the consulting company McKinsey believes that the effective implementation of strategic actions and, through

them, the entire corporate strategy can be discovered in the close and balanced cooperation of the 7 (or, in addition, 8) areas shown in Figure 15[45, 46]. The model grew out of the theory of Galbraith, who analyzed the "western" corporate practices of the 1960s[47].

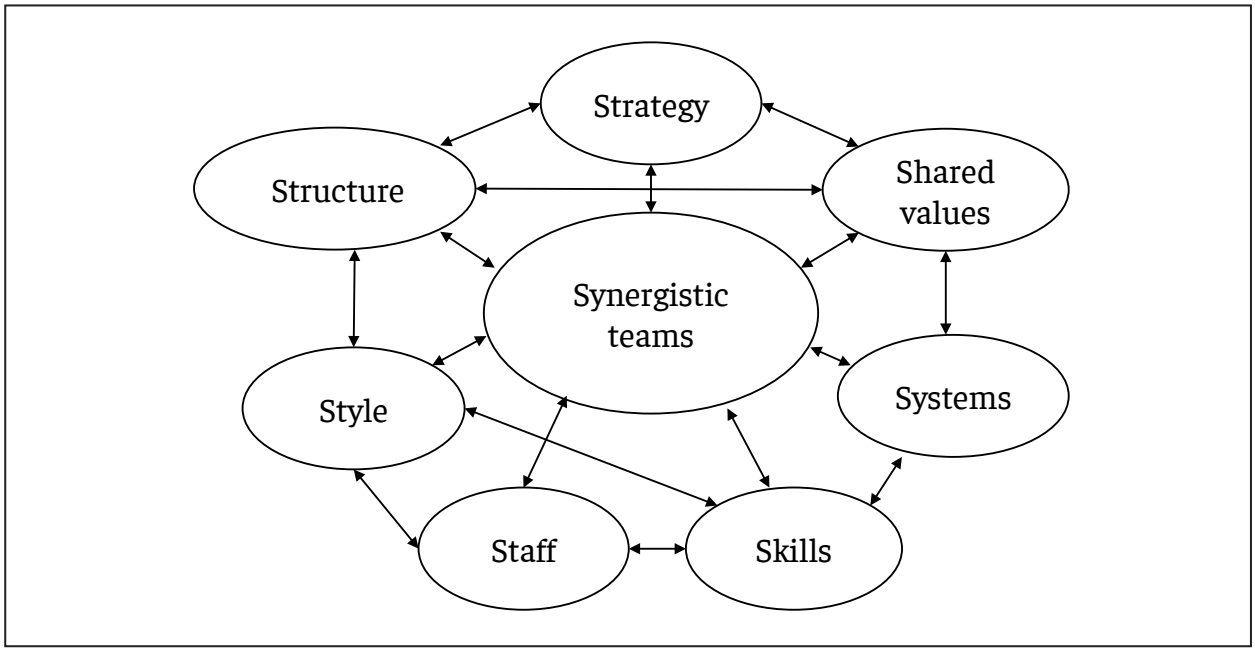

Figure 15. *McKinsey's 8S model*
Source: Fekete[9] and Csath[29]

Strategy: the combination of the vision, the set goals, the organizational values, the mission and the actions to be implemented. It defines the company's product range and services, the markets to be served, the way of value creation and the sources of competitive advantage. „The other elements must work together to help the strategy succeed."[29, 45]

Organization: Makes points of power and decision-making concrete, shows the structure of the company, the method and framework of division of labor and cooperation.

Systems: the combination of formal and informal processes appearing in the company.

Forms of behavior: it shows what decision-makers in a company consider important, what example they set, and how they behave in different situations, especially in crisis situations.

Common values (organizational culture): shows what is considered "good" and what is "bad" in the company. "What the company is proud of and what it wants to be proud of." Who is considered successful, what does the company value and what does the company refrain from doing?

Employees: characterizes all the company's employees together with their demographic data, knowledge, experience, motivation and commitment to the company.

Capabilities: include the firm's strengths, core competencies, and the quantity and quality of available resources.

Teams working in harmony: the model has recently been supplemented, and this 8th element is the central core, it brings together the other factors[29, 45].

8.6 Factors influencing the implementation of the strategy

The implementation of the strategy also means that we move from the level of strategic thinking to the level of action plans. All employees of the organization must be committed to the implementation. Human resources are the most critical factor: without understanding and commitment, management faces significant problems. The implementation strategy moves from top to bottom and affects all divisions and functional levels. An incompletely implemented but well-functioning action is better than a perfect plan that

only exists on paper. Unfortunately, significant differences can arise between the formulation and implementation of the strategy in practice, due to the factors affecting the strategy. Such, for example:

- lack of clearly formulated and laid down goals,
- inadequacy of descriptions, regulations, ideas, and administrative advice supporting the realization of the goals,
- incorrect distribution of resources,
- dissension within the management,
- structural inadequacy (the structure of the organization cannot be matched to the strategy, e.g. implementing an innovation-oriented strategy in a rule-oriented structure (see Figure 8)[22].

The implementation of the strategy can have different speeds and effectiveness in the case of different organizational forms (configurations: e.g. linear, functional, matrix).

8.6.1 Change management

There are different levels of change, for example changes at the organizational level and at the individual level. At the organizational level, adaptation to changes can be realized along three strategies. We speak of reactive adaptation when the organism changes after the fact, out of necessity, only after changes in the external environment. In the case of proactive adaptation, the organization anticipates expected environmental changes, takes steps and changes. Proactive influence is when the organization tries to expand its own possibilities by influencing and changing its microenvironment.

Most changes affect companies from the outside.

There may be external motives:

- changes in the international environment,
- social changes,
- technological changes,
- economic changes, such as changes in living standards, purchasing power, competitors, suppliers, employment,
- ecological changes,
- political changes, such as election campaigns, scandals, government stability, changes in the composition and program of the political elite,
- changes in the legal environment, for example changes in laws, regulations, orders[48].

Another group of motives for organizational changes comes from within the organization. The members of the organization generate the change, which can be resource development, problem discovery, retreat or renewal. These changes typically take place in a planned manner. Changes initiated by the members of the organization can be both top-down and bottom-up, depending on the role the management assigns to the employees in planning and implementing the change.

Change management communication has been a challenge for modern organizations for a long time. In the midst of chaos and uncertainty of change, employees often look to managers for information, reassurance and support. The management of change is therefore a permanent management challenge that includes individual and collective efforts within the organization. Among the tools used by leaders to promote change, the mobilization of activities is considered particularly important, as it allows leaders to activate the necessary resources and processes[49]. It is worth mentioning here that the so-called transformational leadership significantly influences employees' trust in management and the behavior shown during organizational change.

8.6.2 Wellbeing factors in the workplace

Workplace well-being can be defined as the employees' sense of well-being resulting from work. Essentially, this includes all factors that are related to work, from the quality and safety of the physical work environ-

ment, to the employee's feelings about work, to workplace relationships. According to Kun, the defining characteristics of workplace well-being include, among others, the possibility of personal control and decision-making, the variability of tasks, physical security, the possibility of earning money, supportive management, recognized social position, social relations, supportive colleagues, the possibility of using skills, an unequivocal work environment and information[50].

Organizations that pay attention to well-being create tools and conditions that enable efficient work, maintaining work-life balance, and achieving personal aspirations and goals. The goal is to create a workplace culture where all employees are taken into account, valued and recognized. An atmosphere of mutual respect promotes the development of working relationships and contributes to productivity and business performance, while the employees' sense of well-being also becomes more favorable. Perhaps the most important factor in employee well-being is a good relationship with direct managers.

For example, on its recruitment page, Caterpillar prioritizes the following: globality, the chance to work with the best, respect for the value of work, support and motivation, and a positive company culture[5].

Farkas writes that the importance of well-being at work is well indicated by the fact that a given person spends approximately 100,000 hours at work over his or her entire life[51]. The opinion of Tancsics is that it is important for organizations not only to retain and acquire employees, but to keep the well-being of their employees in mind, as its improvement offers positive effects for the company. He puts it this way, "to the extent that employees feel better at their workplace, they miss less, their productivity increases, and thus a higher level of customer satisfaction can be achieved. And there is a need for improvement, because according to an American survey, 76 percent of people are not happy at work"[52]. The costs resulting from employee dissatisfaction and other problems are closely related to absenteeism, early retirement and job abandonment, which cause a decrease in productivity, although almost unnoticed. Companies are therefore increasingly coming to the realization that it is worthwhile to pay attention to the well-being and health of their employees in order to gain long-term benefits. Caring for well-being and health can be defined as the joint responsibility of employers and employees[50]. The situation is definitely complicated by the fact that nowadays there are more and more generations on the labor market in parallel with each other: in 2020 there will be 5 generations. Different generations think differently about well-being.

Due to the apparent labor shortage, it has become even more important for organizations that their employees love their work and perform their daily tasks with dedication. Toldy draws attention to the fact that most companies are still working on increasing commitment to the organization, "even though we have known this since Csíkszentmihályi", that flow (experience) occurs in people during work and not in relation to the company. He believes that the best way to achieve a flow experience is to support well-being, "because it frees a person from disturbing barriers."[53]

Basically, the task of management is to recognize problems related to employee well-being and to increase well-being.

8.7 Monitoring – factors influencing the success of the competition strategy

Even the most sophisticated and well-implemented strategy can become obsolete as soon as the external or internal environment of the organization changes. For this reason, it is inevitable to regularly check the strategy and, if necessary, adjustment of it. If the monitoring is continuous, we can avoid the strategy causing a critical situation, which has irreversible and serious consequences. It is always advisable to keep three steps in mind: always look back at the basics, compare the expected and actual results, and correct the given processes.

For most organizations, the evaluation analyzes whether the company's fortune, profitability, sales volume, productivity, profit margin, earnings per share, or dividends have increased. Unfortunately, this argument can be misleading, since the incorrect implementation of the competitive strategy does not neces-

[5] caterpillar.com, 2021

sarily show signs in the short term. Even the most successful, strongest companies must constantly evaluate results, pay careful attention to the actions of competitors, and not get comfortable at the height of success.

Herczeg refers to the fact that the current level of performance of each key area is summarized in tabular form. In the case of processes, for example, we can examine transparency, organization, costs, and value contribution[45]. For human resources, education, knowledge level, commitment, flexibility can be analyzed – the factors that we consider essential. The efficiency of their operation can be evaluated with "bad", "medium" and "good" ratings. After that, you can associate a goal to improve individual processes and formulate an action plan and tasks.

It is no coincidence that the management of organizations is using some version of corporate governance systems more and more frequently. If such a system works at the company, by introducing it:

- the key management processes become clear,
- the efficiency of analysis and control increases,
- it becomes possible to implement business administration at a high level in an electronic environment,
- data processing is being modernized, thus it is possible to access crucial information faster, in a traceable way and with a wide range of query options,
- external expectations are met at a higher level (e.g. towards the owner, participants of the farming environment),
- process and organizational development ideas can be introduced and controlled more quickly,
- and cost effectiveness improves[54, 55].

One of the basic questions of strategy creation: how can we develop and implement a strategy that ensures a lasting competitive advantage[56]. Let's recall: the idea of strategy was already introduced during ancient warfare, but it gained real importance in business life centuries later and became the defining tool of business success, outstanding results, one could say excellence. We think that it will not be any different in the future either: a consistently implemented, hard-to-copy strategy will continue to be an inseparable player in effective market role.

Bibliography

[1] Takács, A. (2015) Sikeres szervezeti átalakítás a változásmenedzsment kulcs elemeivel. In: Karlovitz, J. T. (szerk.) Fejlődő jogrendszer és gazdasági környezet a változó társadalomban. International Research Institute, Komárno, Szlovákia pp. 220–231.
[2] Verdin, P., Tackx, K. (2015) Are You Creating or Capturing Value? A dynamic framework for sustainable strategy, M-RCBG Associate Working Paper Series, No. 36, Mossavar-Rahmani Center for Business & Government Weil Hall, Harvard Kennedy School, www.hks.harvard.edu/mrcbg (Letöltve: 2019. 08 .06.)
[3] Markó, E. (2018) A stratégia alapfogalma és a Török Kft. rövid bemutatása. Kaposvári Egyetem GTK, vizsgadolgozat.
[4] Marosán, Gy. (2006) A 21. század stratégiai menedzsmentje. Műszaki Kiadó, Budapest.
[5] Rónaszéki, Zs. (2015) Az Alba Adó Bt. stratégiai elemzése. Kaposvári Egyetem GTK, szakdolgozat.
[6] Biczó, Sz. (2011): A Kapos Autó Kft. stratégiai menedzsmentje. Szakdolgozat, Kaposvári Egyetem GTK, Kaposvár.
[7] Vermeylen, S. (2011) Stratégiai menedzsment. [PPT] http://www.ekt.bme.hu/MCM-FLHU/Stratmen.PDF (Letöltve: 2019. 08 .06.)
[8] Nábrádi, A., Pupos, T. (2010) A stratégiai és üzleti tervezés gyakorlata. Szaktudás Kiadó Ház, Budapest.
[9] Fekete, J. Gy. (2011) Környezetstratégia. A stratégiai tervezés folyamata. https://www.tankonyvtar.hu/hu/tartalom/tamop425/0021_Kornyezetstrategia/ch03.html (Letöltve: 2019. 08. 06.)
[10] Sinek, S. (2019) Kezdj a miérttel. HVG Könyvek, Budapest.
[11] Bereczki, Cs. N. (2019) Vezetői gondolkodás vizsgálata startup vállalkozások körében. TDK dolgozat. Kaposvári Egyetem GTK, Kaposvár.
[12] Hall, E. T. (1976) Beyond culture. Anchor Books, USA
[13] French, W. L., Bell, C. H. (2009) A szervezetfejlesztés meghatározása. In: Balázs É. (vál. és szerk.): Oktatásmenedzsment. OFI, Budapest. https://www.ofi.hu/szervezetfejlesztes-meghatarozasa
[14] Virág, O. (2006) A szervezeti kultúra mint összetartó, integráló erő egy virtuális szervezet mindennapjaiban. [Vizsgadolgozat] Budapesti Corvinus Egyetem Gazdálkodástudományi Kar Vezetéstudományi Intézet. http://mek.oszk.hu/03900/03905/html (Letöltve: 2019. 08 .06.)
[15] Bakacsi, Gy. (2015) A szervezeti magatartás alapjai. Alaptankönyv bachelor hallgatók számára. Semmelweis Kiadó, Budapest.
[16] Cameron, K., Quinn, R. E. (2005): Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework. Jossey Bass, USA.
[17] Bakacsi, Gy. (2004) Szervezeti magatartása és vezetés. Aula, Budapest.
[18] Tóth, J. (2006) Vállalati gazdaságtan. MVT Munkaközösség. BME, Budapest.
[19] Demeter, L., Fülöp, G., Hné Kacsó, E., Kádek, I., Námor, A., Papanek, G., Román, R., Tánczos, T., Turóczi, G. (2007) Gyakorlati vállalkozási ismeretek. PR-Editor Kft.

[20] Laáb, Á., Berencsi, B. (2014): Versenystratégia. Előadás. BME Pénzügy Tanszék, Budapest.
[21] Fleet, van D., Fleet, van E., Seperich, G. (2014) Agribusiness – Principles of Management. Delmar Cengage Learning, USA.
[22] David, F. R., David, F. R. (2015) Strategic Management. Concept and Cases. A Competitive Advantage Approach. 16th. ed. Pearson education Limited, USA.
[23] Mező, E., Szűcs, E., Takács, T., Matkó, A. (2014) A marketing stratégia és a vevői elégedettség mérés kapcsolata a Garda étterem és pizzéria esetében. Debreceni Műszaki Közlemények, 2014/1, 18–34.
[24] Lőre, V. (2011) A tudástőke szerepe a vállalati stratégiában. Doktori értekezés. Széchenyi István Egyetem, Regionális- és Gazdaságtudományi Doktori Iskola, Győr.
[25] Lukčo, M. (2013) Üzleti tervezés. „Gazdasági szakemberek képzése országhatáron átnyúló távoktatási hálózatban" projekt (CROSSEDU) HUSK/1101/1.6.1/0300, Kassa, pp. 1–94.
[26] Barakonyi, K. (2000) Stratégiai Menedzsment, Nemzeti Tankönyvkiadó Rt., Budapest.
[27] Porter, M. E. (1998) Competitive Strategy: Techniques for Analyzing Industries and Competitors. Free Press
[28] Chikán, A., Czakó E. (2009) Versenyben a világgal. Vállalataink versenyképessége az új évezred küszöbén. Akadémiai Kiadó Zrt.
[29] Csath, M. (2008) Stratégiai tervezés és vezetés a 21. században. Nemzeti Tankönyvkiadó, Budapest.
[30] Chikán, A. (2003) Vállalatgazdaságtan. Aula Kiadó, Budapest.
[31] Dobák, M. (2008) Szervezeti formák és vezetés. Akadémiai kiadó, Budapest.
[32] Marosán, Gy. (2013) Stratégiai menedzsment oktatási segédanyag (ppt). Külkereskedelmi Főiskola, Budapest.
[33] Balaton, K., Tari, E. (2014) Stratégiai és üzleti tervezés – Stratégia, tervezés, módszerek. Akadémiai Kiadó, Budapest.
[34] Benedek, A. (2018) A Xerox komparatív versenyelőnyei. [Vizsgadolgozat] BGE Külkereskedelmi Kar.
[35] Kiss, P. (2015) Az MKB Bank stratégiájának elemzése. Kaposvári Egyetem GTK, szakdolgozat.
[36] Dankó, L. (2006): Termék sztenderdizálás vs. differenciálás a nemzetközi marketingben Gazdaságtudományi Közlemények, 4, 479–495.
[37] Barnard, F., Akridge, J., Dooley F., Foltz, J. (2012) Agribusiness management. Routledge, USA.
[38] Weihrich, H. (1982): The TOWS matrix — A tool for situational analysis. Long Range Planning, 15(2), 54–66.
[39] Czeglédi, L. (2011) Minőségmenedzsment. http://www.tankonyvtar.hu/hu/tartalom/tamop425/0005_42_minosegmenedzsment_scorm_03/336_a_swotanalzis.html (Letöltve: 2019. 08 .06.)
[40] Pohner, P. (2018): Egyes stratégiai elemek és wellbeing tényezők vizsgálata az Argos Feed Group Zrt-nél. Kaposvári Egyetem GTK, Kaposvár.
[41] Szőrös, K., Kresalek, P. (2013) Üzleti tervezés. https://www.tankonyvtar.hu/en/tartalom/tamop412A/0007_d1_1075_1077_uzletiterv/borito_arNPvUwfmN8RkuyM.html (Letöltve: 2019. 08 .06.)
[42] Hajdú, N. (2017) A konverziós ráta marketingcontrolling szempontú optimalizálási lehetőségei. Controller Info, 5(3) 7–11.
[43] Varsányi, J. (1996) Üzleti stratégia – üzleti tervezés, Nemzeti Tankönyvkiadó Rt, Budapest.
[44] Gyurkó, Gy. (2009) Szervezéstechnológia jegyzet. Budapesti Gazdasági Főiskola, Budapest.
[45] Herczeg, J. (2014) Stratégiai menedzsment, Nyugat Magyarországi Egyetem.
[46] Szellőné Fábián, M. (2014) A szolgáltatások minőségének értékelése és biztosítása. Oktatási segédlet. Pécsi tudományegyetem, Pécs.
[47] Galbraith, J. R. (2001): Designing Organizations: An Executive Guide to Strategy, Structure, and Process Revised. Pfeiffer.
[48] Farkas, F. (2004) Változásmenedzsment. KJK-KERSZÖV, Budapest.
[49] Canterino, F., Cirella, S., Piccoli, B., Shani, A. B. (R.) (2020) Leadership and change mobilization: The mediating role of distributed leadership, Journal of Business Research, 108, 42–51. https://doi.org/10.1016/j.jbusres.2019.09.052
[50] Kun, Á. (2010) Munkahelyi jóllét és elköteleződés Munkaügyi Szemle, 54(2), 35–41.
[51] Farkas, T. (2019) Hogyan teremtsük meg a dolgozók jóllétét az irodában? http://blog.iroda.hu/irodapiaci-blog/hogyan-teremtsk-meg-a-dolgozk-jlltt-az-irodban/136003
[52] Tancsics, T. (2018) Wellbeing: divathóbort vagy kulcs a jövőhöz? https://www.portfolio.hu/ingatlan/iroda/wellbeing-divathobort-vagy-kulcs-a-jovohoz.293254.html
[53] Toldy, A. (2017) Well-being, út a jövő munkahelyeihez. http://www.workforhumans.com/blog/Well-being,-ut-a-jovo-munkahelyeihez/27
[54] Rózsa, M. G. (2005): Scorecard alapú szervezetirányítási módszerek bemutatása. [Vizsgadolgozat] BGF Külkereskedelmi Főiskolai Kar.
[55] Horváth, A. (2019) Társadalmi felelősségvállalás. [Vizsgadolgozat] Kaposvári Egyetem GTK.
[56] Gelencsérné Takács, T. (2019) Stratégiai menedzsment. Vállalatelemzés. [Vizsgadolgozat] Kaposvári Egyetem GTK.

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CHAPTER 9

Food marketing and food supply chains – marketing strategies and tools

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9.1 Introduction

In order to turn a basic agri-food product into something affordable, useful, tasty or just attractive to the end consumer, it needs to be refined and equipped with added properties that will make it different from the same or similar products of the competition.

In addition, it is very important to initiate and encourage such processes in the short supply chain, and the only possible way is with a customized marketing strategy that includes customized tools and procedures.

Short food supply chains are local or regional networks of food producers that work together to build locally based, independent food economies[1]. These local food networks emphasize the sustainable production, processing, distribution and consumption of food that are integrated to improve economic, environmental and social health in a particular place and are considered part of the global sustainability movement[2]. Local food networks include organizations that produce, distribute and promote domestically produced products. Although grocers, restaurants and other organizations may include locally produced products, the local primary production and processing market is uniquely positioned in local food networks[3]. One of the key aspects is the emphasis on the local origin of the product, which can be defined as the tendency of consumers to buy locally produced goods and services. Local food networks are an alternative business model to global corporate models in which producers and consumers are separated by a chain of processors, producers, deliveries and retailers. As the food industry grows, consumers are not always able to assess the quality of food.

On the other hand, local food chains have re-established a direct relationship between producers and consumers to emphasize product quality characteristics that include freshness and durability, but also features such as the way and place of production. Traditional grocers also respond to high demand for local products, but there is potential for consumer cooperatives to have an advantage in scope, customer focus, and credible community orientation for local products.

9.2 Food marketing strategies

Marketing in the context of the agricultural domain traditionally refers to activities that take place from the field or threshold of the agricultural producer to the final consumer. Large systems think differently about marketing, so they are focused only on those activities that are directly related to the sale of their products.

The marketing strategies used by agricultural and food companies manage the price, volume and range of products they sell. Likewise, marketing strategies can affect both price and product quality. Thus, the strategies available to businesses that sell food are different from those used by primary food producers. But they all have a common goal, and that is the economic growth of their businesses. Growth requires an adequate financial return in order to be achieved on a sustainable basis, but it also affects the financial return. Marketing strategies are developed to achieve the goal of growth, which is the main concern of companies in the food industry[4].

The company's business is defined by the depth and breadth of its product range, market and target segments that are served. The segments are based on differences in consumer needs and ways of meeting those needs.

Clearly profiled marketing strategies in accordance with the basic principles of the segmentation process affect the growth of product sales and markets. These strategies are interrelated, and consistency in their use is essential to achieving the company's growth goals[5, 6]:

- Geographically diverse sales enable the expansion of retail space and increase consumer exposure to food products and lead to increased sales. With higher sales, economies of scale, increased sales and production can also be achieved. However, a larger sales area can bring regional differences in consumer preferences, which must be met.
- The desired product diversification can be achieved by developing new products or redesigning or rebranding an existing product. Companies need to develop new products or change existing ones because most products have a generally limited life cycle. Sales increase after the introduction of a new product, then reach a high level, followed by a decline. The company's total sales would thus be reduced if new products were not introduced. The company has products in its range that differ in design, packaging, ingredients, quality or other properties. Each product or its variation is aimed at a specific group of consumers. Although product diversification strategies increase the variety of food products available to consumers, they may result in the proliferation of products with only minor differences in quality or other properties. A company can maintain or expand its market share by producing and marketing several product variations that might otherwise present a rival company.
- Food producers can label products with their own brands or distributor's brands (private label) or sell products without a brand. This decision is greatly influenced by the intermediaries in the distribution channels that will use the products. A company must be able to distinguish its brands from competing products and communicate those differences to consumers. As a result of this communication, consumers develop brand loyalty, which gives customers (wholesalers and retailers) some bargaining power and reassures processors that their products will find their way to retail shelves. The development of strong brands requires attention to packaging and product positioning with respect to competition. Private labeled and unbranded products are often those that are difficult to distinguish and for which there may be few direct customers. Efficiency and low cost are important for companies that sell these types of products.
- Advertising costs for food products are less intensive, and the content is more informative. Examples of such products are products such as milk, meat, salads, etc. For products that can differ significantly from each other, more convincing advertising content is used. Advertising informs consumers about product attributes and is often aimed at attracting certain groups of consumers. Establishing a consumer franchise through brands and introducing new products requires high costs for advertising and promotion. Promotions can take many forms.

The prices that food producers can achieve contain relatively low profit margins, especially for products that are difficult to distinguish, non-branded products and private label products. Efficiency and low

production and distribution costs are therefore important for the survival of agri-food businesses. The prices of branded products are more flexible, but manufacturers are still subject to competitive forces. Uncertainty about how competing firms will react to the pricing strategy means that the firm must be prepared to take countermeasures. Prices are influenced by product design and the market segment to which the product is targeted. Grocery stores and restaurants also set prices that are in line with the product range.

The marketing strategies devised by food producers are very convincing and this implies that consumers who are exposed to food marketing campaigns easily accept the messages intended for them, including those for choosing unhealthy food[7]. Television and the Internet seem to be the most powerful ways to influence food consumers[8], especially through the use of neuromarketing techniques that, for example, encourage consumers to favor taste when choosing food. The same thing happens on websites and social media. Taste is a crucial ingredient in food marketing strategies[9] and usually, food marketing uses contexts associated with this attribute to design its plans and influence consumers.

The main focus on building local food supply systems is to raise awareness of the impact of local food on the social, economic, environmental and public health of the community[10]. These activities are carried out in the form of simple educational activities, public events, presentations, media campaigns, etc. Sales promotion includes tactics that can influence consumer buying behavior.

From a managerial point of view, sales promotion is gaining in importance as a marketing strategy[11]. Marketing strategies in the form of sales promotion most often include tools such as advertising, sales promotion, personal selling, public relations and publicity.

9.3 Management of marketing in agriculture and food marketing

Agriculture and related sectors can play a significant role in the economic transformation of individual societies and economies, especially in the areas of rural development and national food security. Agriculture by food production meets the basic needs of the human species. About a century ago, the farmer produced food mainly for his own consumption or for direct exchange, and in this way he was self-sufficient and self-sustaining. But in the meantime, the economic environment and production conditions have changed significantly. Technological progress in the form of high-yielding varieties, the use of fertilizers, insecticides, pesticides, mechanization has led to a significant increase in agricultural production, and thus greater market surplus. Improved production is accompanied by increasing urbanization, income, changing lifestyle and eating habits of consumers, and increasing connectivity with foreign markets. Today, consumers are not limited to rural areas where food is produced. Furthermore, the growing demand for processed products requires added value to raw agricultural products. These developments require the movement of food products from producers to consumers in the form of value-added products[12].

Marketing in the domain of agricultural production most certainly includes its food component, so it is much easier to talk about food marketing. Food marketing covers all aspects of classical marketing management related to its main subject, which is food. Therefore, such marketing is not limited to primary agricultural products, but much wider. It is a process that begins with a decision to produce marketable agricultural goods, involving all aspects of the market structure or system, financial and institutional, based on technical and economic considerations.

Food marketing is an important tool[13] to build and maintain markets by creating bonds of trust and loyalty between producers / sellers and consumers. Food marketing depends on several different dimensions, especially those related to the specificities of the food and services sector. In any case, food marketing as an external factor influencing consumer choice is a powerful instrument that can be used to promote public campaigns, such as those related to healthy eating[14].

Agricultural marketing is a slightly broader term than food marketing, but it definitely doesn't rule it out. It covers all those activities that are involved in supplying agricultural inputs to farmers and the movement of agricultural products from farms to consumers. The agricultural marketing system includes two main subsystems, ie product marketing and input (factor) marketing. The product marketing subsystem includes farmers, rural/primary traders, wholesalers, processors, importers, exporters, marketing cooperatives, etc.

The input subsystem includes input producers, distributors, related associations, importers, exporters and others who provide farmers with various inputs in agricultural production. A dynamic and growing agricultural sector requires fertilizers, pesticides, agricultural equipment, machinery, diesel, electricity, packaging materials and repair services produced and supplied by industry and non-agricultural enterprises. Expanding the size of agricultural production encourages advanced connections by providing surplus food that requires transport, storage, processing, packaging and retail sale to consumers. These functions are performed by non-agricultural enterprises. Furthermore, if the increase in agricultural production is accompanied by an increase in real incomes of agricultural families, the demand of these families for non-agricultural consumer goods increases as the share of income spent on non-food and durable goods increases with increasing real per capita income. Several industries are therefore finding new markets for their products in the agricultural sector. The subject of agricultural marketing includes marketing functions, agencies, channels, efficiency and costs, price range and market integration, surplus producers, government policy and research, training and statistics on agricultural marketing and import/export of agricultural products. The general objective of agricultural marketing is to help primary producers, ie farmers, to obtain appropriate prices for their products[15].

Agricultural marketing plays an important role not only in stimulating production and consumption, but also in accelerating the pace of economic development. It is the most important multiplier of agricultural development. In the process of transition from traditional to modern agriculture, marketing emerges as the biggest challenge due to surplus production resulting from change. The importance of agricultural marketing is revealed from the following[16]:

- An efficient agricultural marketing system leads to optimization of resource use and output management. An efficient marketing system can also contribute to increasing market surplus and reducing losses resulting from inefficient processing, storage and transportation. A well-designed marketing system can effectively distribute the available stocks of modern inputs and thus maintain a faster growth rate in the agricultural sector.
- An efficient marketing system provides higher income levels to farmers by reducing the number of intermediaries or limiting the costs of marketing services and abuses in the marketing of agricultural products. An efficient system guarantees farmers better prices for agricultural products and encourages them to invest their surpluses in purchasing modern inputs to increase productivity and production. This in turn results in an increase in market surplus and farmers' income.
- An efficient and well-connected marketing system expands the product market by expanding the market inside and outside the country. Expanding the market helps to constantly increase demand and thus guarantees higher revenue to the manufacturer.
- Improved and efficient agricultural marketing system helps the growth of agricultural industries and stimulates the overall development process of the economy.
- An efficient marketing system helps farmers to plan production in accordance with the needs of the economy.
- The marketing system helps farmers to adopt new scientific and technical knowledge related to production and the market.
- The marketing system ensures the creation of new jobs in the field of packaging, transport, storage and processing
- Marketing activities add value to the product thus increasing the national gross national product and the net national product.
- The marketing system is essential for the success of development programs that are designed to increase economic well-being within rural areas and beyond.

9.3.1 Local marketing of food / characteristics of agricultural production and products

The subject of food marketing can be treated as a separate discipline because agricultural products as well as processed products contain some special features that make them different from other consumer products[17]:

1. Most fresh and unprocessed products are perishable in nature, and their perishability period varies from a few hours to several months. Due to their perishability, it is almost impossible for manufacturers to set a reserve price for their products. The extent of perishability of fresh and unprocessed products can be reduced by the processing function. Perishable products require quick handling and often special cooling, which increases marketing costs.
2. Agricultural products are produced in a certain season. They cannot be produced all year round. This leads to the emergence of seasonality of prices. During the harvest season, prices of agricultural products fall. But the supply of manufactured products can be adjusted or balanced throughout the year.
3. The bulkiness characteristics of most agricultural products make their transport and storage difficult and expensive. Often the place of primary production is not close to the place of sale or processing, which then includes additional costs, ie these costs affect the formation of the final price. The price of bulky products is higher due to higher costs of transport, handling and storage.
4. There are large differences in the quality of agricultural products, which makes it somewhat difficult to evaluate and standardize them. There is no such problem in industrial products, ie processed products, because uniform qualities can be produced.
5. The supply of agricultural products is uncertain and irregular due to the dependence of agricultural production on natural conditions. With variable supply, while demand remains almost constant, prices of agricultural products can be significantly higher and subject to fluctuations.
6. Agricultural products are produced throughout the country, and most small producers have small holdings, and thus their production quantities offered on the market are small and sometimes economically uncompetitive. This makes it difficult to evaluate the offer and creates a problem in marketing.
7. In addition to the problems in estimating the total agricultural supply of small farms, individual farmers face a typical market situation because they cannot influence the market supply. Furthermore, due to the inelastic nature of demand for most agricultural products, the market price for their product is determined independently of supply. In this context, the individual farmer should operate in the consumer market. In contrast, larger companies, due to their higher market share, can to some extent control the supply and thus influence the price of the product.
8. Most agricultural products need some form of processing before they are bought and consumed by final consumers. The processing function, although it adds value, increases the price range of agri-food products. Processing companies enjoy market advantages. This situation sometimes creates disincentives for producers.

9.3.2 Short food supply chains as an alternative to promoting local food production

Initially, short food supply chains were associated primarily with the demand for social proximity. Consumers wanted direct contact and a relationship of trust with producers. The growing interest in short food supply chains also reflects consumer demand for quality and traceability, given the growing need for a person's sense of security that includes that health component. This trend also marks the so-called ethical consumption of food aimed at encouraging social, economic or environmental change through individual decisions about what, how and when to buy[18]. For farmers, short food supply chains are attractive because of the opportunities to diversify production, achieve greater added value and ensure more stable incomes. For local communities, short food supply chains are a means of relocating value chains to maintain added value in their territories, create jobs, create added value from intangible assets, strengthen the resilience of their territories in times of crisis, and become an important vector for human growth and attraction, material and financial capital. Although short food supply chains are usually associated with better product quality or more sustainable production and commercial practices, these characteristics do not develop automatically as the place of production alone does not guarantee quality and safety properties, nor do products have low environmental impact or include social responsibility attributes.

These alternatives are useful for improving the market position of family farms and the living conditions of small farmers. Therefore, it could be concluded that the real marketing impact of short food supply chains on the performance of small farms can be reflected in the following:

- Recognize the value of local cultural and nutritional characteristics of products that serve as a basis for diversification and added value.
- Identification of market trends enables the development of the potential of short food supply chains in relation to demand trends.
- Shorter distances between farmers and consumers mean that farmers will have to take on one or more stages of the distribution and marketing process, activities for which they usually do not have the experience or the necessary logistics.
- One thing common to all food supply chain policies and projects is the creation of partnerships and networks in a wide variety of areas and for different purposes, such as increasing scope, diversifying supplies, adding value or improving logistics efficiency.
- Given the nature of family farms and the products they produce and sell, the success of short food supply chains depends to a large extent on the design and implementation of flexible regulations and legal norms that facilitate their operation.
- To a lesser extent Peru and the United States, show that coordination between multiple ministries, agencies and levels of government is needed to ensure comprehensive and sustainable results.

9.4 Marketing decisions for small food producers

Marketing is the key to the success of any business. To start any successful entrepreneurial venture, a precise and detailed business and marketing plan needs to be developed. A marketing plan will help identify the market and potential demand for the product. Product demand determines the amount of product that consumers will buy in the market at a certain price. The core part of every marketing plan is the marketing mix, ie marketing instruments. Marketing instruments are basically an instrument of marketing management and consist of products, distribution and sales, price and promotion.

9.4.1 Product

After determining the production process and the shape of the product, it is necessary to design the packaging and labels with which it will be equipped. Proper packaging and labeling of products will help ensure shelf life, but other marketing elements are also important. Packaging is not only something that contains a product until the consumer buys it, but it is also a form of marketing communication in the function of product promotion.

Many times the look, shape, convenience and style of packaging are the reasons why a consumer buys a product for the first time. Packaging becomes a silent seller when a product is on the shelf in a store with several other identical or similar competing products. Packaging must attract the attention of consumers. Of course, product quality is also important, as repeat purchases will be made based on quality. However, packaging, packaging and labels can significantly affect the creation of a brand image for a product and a company.

The goal is to create a brand in the minds of consumers that will promote loyalty and encourage repurchase. Packaging material, color combinations and design are important elements in the marketing process of creating a product and communicating its values to the consumer.

9.4.2 Distribution and sales

Location includes the distribution or physical path of the product from the place of production to the final consumer. Different levels or phases of distribution create opportunities for different markets and product marketing strategies. A simple example of the flow of goods from production to the consumer is the following: from the manufacturer to the wholesaler to the retailer to the final consumer. One marketing option would be to sell wholesale to the food service industry. The food service industry includes companies such as restaurants, hospitals, schools and other major food suppliers. This requires a different marketing plan than

selling directly to retailers or directly to end consumers. In general, packaging and labeling requirements vary, and the margin between processing costs and sales price will decrease. Every step in the distribution supply chain offers product marketing services. Wholesale distributors offer the benefits of their sales force to sell products at multiple outlets. The manufacturer can use wholesalers or contract with intermediaries to find buyers.

The manufacturer can also place the product at a retail point without the help of wholesalers or any other intermediary. This method usually requires the manufacturer to have a dedicated point of sale. Specialized retail markets generally require more time and effort from manufacturers, but usually allow for higher margins.

Finally, direct sales to end consumers can be achieved in many ways: through home sales, mail ordering, social media networking, or through websites. The place to place a product on the market can be any of the different stages of distribution or a combination of several marketing channels. A marketing plan should help identify the market or combination that offers the highest possible profitability.

9.4.3 Price

The price depends on the cost of production and delivery of the product to the market. The price must cover the total costs, return the profit and be competitive in the market. When determining the prices of products, the total costs must be taken into account. They are equal to the variable cost plus the fixed cost. Variable costs are costs that vary in proportion to the amount of product produced. Fixed costs are costs associated with the business, which are fixed for a certain period of time regardless of the amount of production. Fixed costs include rent, insurance, property taxes, depreciation and interest on debt. Variable costs can be divided into two categories: cost of goods sold and operating costs. The cost of goods sold is all costs related to the processing of the product and its preparation for sale. The cost of goods sold includes raw materials and supplies used directly in the production of products, work on product processing, direct utilities used in the process and packaging. Operating costs include office supplies, other utilities, advertising, repair and maintenance, bookkeeping and more. In other words, operating costs include all variable costs that are not directly involved in product production but are required in day-to-day operations. The price must always be based on cost first, and then it can be adjusted for other factors. Some other reasons that can influence the definition of different prices are the price of competition, seasonality of products, specialization and location, etc.

9.4.4 Promotion

What's so great about the product? What consumer needs does the product meet? How can a product improve the lives of consumers? These are just some of the questions that can help build a promotional campaign. Advertising is one way to promote a product. Advertising can be achieved through a variety of media. Radio, television, newspapers, magazines, posters, social networks and the Internet are some of the common media used for advertising. However, paying for advertising can be expensive and even in some situations be too expensive for small businesses.

There are some online tools that can be used to determine the sociodemographic characteristics of potential advertising-targeted markets. Free advertising is great if available. It is important to build a relationship with local media outlets and encourage them to create informative stories about the company or product. The media should be regularly informed about any special activities related to the product or company. It is important to participate in food exhibitions, specialized sales fairs or tourism promotional events throughout the region because such events imply a multitude of direct contacts with potential and actual consumers. This is a great way to encourage consumers to try a product, and retailers generally love any activity that encourages consumer traffic.

With the help of smart mobile technologies, it is possible to make the food business visible on the Internet and social networks. Promotion refers to brand exposure and awareness. Promotion requires creativity, but also provides good visibility of the product in the local market.

9.5 Food product branding

Marketing is a priority for the success of any business, especially in the food production sector, from small independent farms to large multinational producers. Food marketing involves different actions and may include building relationships with consumers, raising brand awareness, developing new products, promoting them through advertising, and even paying stores for prominent shelf space, all in order to boost sales[19]. Food marketing also has the role of a kind of agent that can regulate and channel patterns of food consumption, which can also have an impact on consumer health. Certainly, in the not-so-distant past, marketing served as an instrument exclusively for stimulating consumption, up to its maximum limits, without caring about the consequences for man, nature or society. In this sense, its role was negative, as obesity, diabetes, cardiovascular disease, etc. emerged as negative consequences related to food consumption, which was causally related to excessive consumption, primarily unhealthy foods. Today, marketing has a role not only to stimulate sales, but to stimulate socially and healthily desirable patterns of food consumption in a responsible and sustainable way. Therefore, the potential of marketing to affect nutrition and health raises some important questions, and one of these ways is communication through branding and labeling of food products.

Recently, the importance of the brand in the function of stimulating the financial growth of agri-food companies has been increasingly recognized. In order for this link to be clear and work, it is necessary to identify the factors influencing the creation of a strong consumer franchise by branding food products[20]. The consumer franchise represents the consumer's awareness of his relationship and willingness to repurchase a brand as a result of a cumulative image of the product as a result of long-term product exposure or product marketing[21]. Therefore, when it comes to the product brand, ie its acceptance by consumers, and in the field of food production, two factors are very important, and these are the order of entering the market and investing in promotion. Companies that are the first to enter the market with their products have more pronounced competitive advantages than those that follow it[22]. That is, this logic also applies to product brands, leading product brands obviously have added value compared to brands that are in another or some further position. Products launched under a new brand early in the life cycle of the product category earn a higher market share than those introduced later[23]. Although most food products are present on the market, those who were the first to develop a brand, i.e. a strong consumer franchise, are successful. In addition, advertising, ie the variable of promotion, plays a very important role.

High perception of quality, including consistency of quality, is a characteristic of strong brands. Product quality consists of two dimensions: expected product quality and perceived product quality[24]. These dimensions are closely related to quality indicators and quality properties, as well as to the different stages of quality assessment. For example, the properties of fruit quality can be, taste and juiciness. They can be judged only at the time of consumption. Therefore, consumers will look for other signs to assess the quality of fresh fruit at the time of purchase. Therefore, a brand may be particularly suitable for products that are difficult for consumers to assess. However, consumers can also assess the quality of the fresh product at the time of preparation. In fact, in some cases, the quality of the product may be affected during preparation. Improper or improper preparation, such as overcooking, can spoil or degrade the product. On the one hand, this can reduce the value of the brand because the brand image is easily damaged. On the other hand, in such cases, consumers can look for strong brands to reduce risk. Specific product characteristics that may affect the successful branding of a fresh food product therefore include: product quality, ease of quality assessment and risk of spoilage during preparation. For the first two variables, a positive brand relationship is assumed. No relationship is assumed for the latter.

Price is considered a separate (independent) variable. It is expected to be positively correlated with a strong consumer franchise.

As said, an important feature of many well-known brands is their high quality and consistency of quality. However, it is difficult to meet consistent quality standards for food products because they are natural products. Differences may be due to genetic variations, changes in weather (for fruits/vegetables) or variations in diet (for meat and dairy products). Short-life products are particularly sensitive to changing conditions, making it difficult to create and maintain an image of consistent quality. Negative consumer attitudes can

easily be encouraged. Many of these potential problems can, however, be removed by quality control of the food supply chain. Quality control of the entire food supply chain involves close cooperation and synchronization of the processes of all entities in the vertical marketing system in order to create a more stable consumer output. Thus, two additional factors may affect the success of a food brand, i.e., quality control of the food supply chain and shelf life. Creating supply chain control and a longer shelf life will make it easier to build a consistent brand image and will therefore be positively correlated with a stronger consumer franchise.

Packaging is also an important marketing tool[25]. It communicates the brand name and all the elements it implies, and also has the role of passive non-verbal communication of the product[26]. However, in the case of fresh food, packaging is somewhat ambiguous. On the one hand, it can convey information to the consumer and facilitate product handling. On the other hand, this can have a negative impact on consumers 'perception of the product as fresh, as consumers associate packaging with processed food. Shelves with fresh food have the best image for selling fresh quality products. However, such shelves make it difficult for manufacturers to brand their products, as they have limited control over the packaging material used by retailers on such shelves. So, it is obvious that there are situations when the problem is the branding of certain food products, especially fresh ones, without the use of packaging.

9.6 Digital marketing and food marketing

Digital marketing is the act of selling products and services through channels such as social media, SEO, email and mobile applications. Basically, digital marketing is any form of marketing that involves electronic media. Digital marketing means its online and offline versions, and in fact both types are important for a well-rounded digital marketing strategy. Digital marketing targets a specific segment of the customer base and is interactive[27]. Digital marketing is on the rise and includes search results ads, email ads and promoted tweets, or anything that involves marketing with consumer feedback or two-way interaction between the marketing organization and consumers.

Internet marketing is different from digital marketing. Internet marketing advertising is exclusively on the Internet, while digital marketing can take place via mobile devices, video games or via a smartphone application[28].

In digital marketing terminology, advertisers are usually referred to as sources, while members of targeted ads are commonly referred to as recipients. Sources often target highly specific, well-defined receivers. Digital marketing is a comprehensive term that encompasses all types of internet marketing. It consists of video marketing, email marketing, content marketing, social media marketing, SEO, PPC, display advertising and mobile marketing. In fact, these are digital marketing channels. Digital marketing channels are platforms that you can use to reach your target audience with information about a brand, product or service and appear as:

- *The website* is the center of all digital marketing activities. In itself, it is a very powerful channel, but it is also a medium needed to run various online marketing campaigns. The website should present the brand, product and service in a clear and memorable way. It should be fast, mobile-friendly and easy to use.
- *Pay-Per-Click* advertising allows marketing professionals to reach Internet users on a number of digital platforms through paid ads. Marketing professionals can set up pay-per-click campaigns on Google, LinkedIn, Twitter, Pinterest, or Facebook to show their ads to people searching for terms related to products or services. Pay-per-click campaigns can segment users based on their demographic characteristics (such as age or gender), or even target their specific interests or location. The most popular PPC platforms are Google Ads and Facebook ads.
- *Content Marketing.* The goal of content marketing is to reach potential consumers by using content. Content is usually posted on a website and then promoted through social media, email marketing, SEO or even as a pay per click campaign. Content marketing tools include blogs, e-books, online courses, infographics, podcasts and webinars.

- *E-mail Marketing or marketing via E-mail* is still one of the most effective channels of digital marketing. Many people confuse email marketing with unsolicited email, but that is not the essence of email marketing. Email marketing is a medium for getting in touch with potential consumers or people interested in a product or service. Many digital retailers use all other digital marketing channels to add leads to their email lists, and then use email marketing to create customer acquisition streams to turn those leads into real customers.
- *Social Media Marketing* is a social media marketing campaign to raise brand awareness and build social trust. As it goes deeper into social media marketing, it can be used to reach potential consumers or even as a direct sales channel
- *Affiliate marketing* is one of the oldest forms of marketing, and the Internet has brought it a new broader meaning. In addition to affiliate marketing, influencers promote other people's products and receive a commission every time a sale is made or a trail is introduced. Many well-known companies have affiliate programs that pay large sums of money each month to websites that sell their products.
- *Video Marketing* – YouTube has become the second most popular search engine and many users turn to YouTube before making a purchase decision, learning something, reading a review or just relaxing. There are several video marketing platforms, including Facebook Videos, Instagram or even TikTok that you can use to launch a video marketing campaign. Companies achieve the greatest success with video by integrating it with SEO, content marketing and broader social media marketing campaigns.
- *SMS messages* – Businesses and non-profit organizations also use SMS or text messages to send information about their latest promotions or give opportunities to willing consumers. Political candidates for elections also use SMS campaigns to spread positive information about their own platforms. As technology has advanced, many texting campaigns also allow users to pay directly or give via a simple text message.
- *Digital Marketing Challenges* – Digital marketing poses special challenges for its suppliers. Digital channels are expanding rapidly and digital retailers need to monitor how these channels work, how recipients use them, and how to use them to effectively market their products or services. In addition, it is becoming increasingly difficult to attract the attention of recipients as receivers are increasingly flooded with competing ads. It is also a challenge for digital retailers to analyze the vast amounts of data they collect and then harness that data in new marketing efforts.

Using these channels provides your clients with help or support regarding any issues or challenges. The challenge of data collection and use effectively emphasizes that digital marketing requires a marketing approach based on a deep understanding of consumer behavior. For example, it may require businesses to analyze new forms of consumer behavior, and so on.

The food industry is at the forefront of interactive marketing research and innovation, collaborating with dozens of advertising agencies, marketing companies and high-tech experts to design digital marketing campaigns[29].

Digital technologies allow marketing professionals to create and distribute content related to products or brands. In this way, consumers are no longer passive viewers of commercial messages, but active stakeholders in universal marketing communication. Business-driven media campaigns use a variety of techniques to encourage consumers to get involved in creating marketing messages[30]. This practice converts the conventional advertising model, transforming food consumers from passive consumers of marketing communication into creators and distributors of advertisements[31].

Through continuous data collection and monitoring, it is possible to create personalized marketing and sales content based on unique preferences, behaviors and psychological profiles of users [30]. Personalized marketing evolved from consumer relations marketing, a practice that preceded the creation of the World Wide Web, but became exponentially more sophisticated in the digital age with the advent of a new generation of media platforms and software. Personalization creates a whole new set of issues that were not part of the traditional advertising and marketing paradigm, which requires taking into account the individual nature of commercial transactions in the digital environment, which often includes techniques that are not transparent to the user[32].

Web platforms, and especially social networking sites such as Facebook and the like, further increase the ability of marketing professionals to understand the nature and scope of an individual's social relationships and use them for highly sophisticated marketing campaigns to promote and sell food on social media. Social networking platforms have added a special and important feature to digital marketing, the ability to integrate into the social matrix, which is a complex network of relationships between individuals enabled and monitored online, allowing marketing organizations to access and influence individuals and their communities in ways never before were possible[33].

Using a multitude of new measurement techniques and tools, marketers can learn about the breadth and depth of these social relationships on the Internet, as well as how they work, understanding who is influencing whom, and how the impact process works.

Behavior in food consumption is very complex, and is the result of the interaction of several factors that affect health and nutrition, as well as the connection of people with their social, physical, and macro-level environments[34]. Therefore, it must be considered how digital marketing intertwines with social, psychological and biological factors that play an important role in food consumption. While marketing is generally considered part of the macro-level environment, digital media is linked to all three areas of sustainability.

Unlike television, where exposure to promotional messages is limited to relatively short intervals while watching programs, the ubiquity of digital media culture allows marketers to reach out and engage consumers in more contexts[35]. Marketing is now woven into the very fabric of consumers 'everyday experiences, integrated not only into their media content but also into their social and personal relationships. Therefore, one can no longer talk about marketing messages as isolated, measurable units, but one must take into account the synergistic nature of marketing interactions on different platforms.

Marketing is no longer limited to a specific time and place, its action and its content can be widely distributed and constantly multiplied through a viral process that has no boundaries. Exposure to marketing may be less important than the nature and degree of engagement with classic marketing and brands. In some cases, consumers are actively involved in product development, packaging design, and creation and distribution. Personalization means that each individual has their own unique interactions and relationships with the brands and companies that produce and promote them[36]. The ever-deepening nature of all digital media means that consumers not only watch content, but create a media environment in which entertainment, communication and marketing combine in a seamless array of compelling impressions and experiences.

The impact of marketing is further enhanced in new forms of monitoring and measurement that were not possible before the advent of digital media. Measurement is fully integrated into content, delivery systems and customer interactions. With web analytics, conversation targeting, and other forms of surveillance, marketing organizations can now track individuals online, in the media, and in the real world, monitoring their interactions, social relationships, and locations. These different forms of analysis can increasingly take place in real time, tracking the movement and behavior of users from moment to moment and assessing their reactions to marketing techniques. As a result, different marketing approaches can be tested, refined and customized for maximum performance.

Branding strategies, even outside the digital context, are increasingly focused on infusing more emotional responses than conscious or intentional ones. But in addition to digital marketing, there are additional elements that are intentionally designed to bypass deliberate elaboration or conscious processing of product properties. The role of influence in persuasion has generally been interpreted as a mediator in two-process models. That is, the role of emotions has been studied in terms of the impact of emotional attraction on product use[37]. Unconscious or automatic processes can be the basis of the response to emotionally oriented advertising.

Given the ubiquity of digital media, exposure to marketing has become a common occurrence, creating a level of knowledge that may go unnoticed but results in significant marketing effects. According to the performance model, only people who are exposed show inclination for things because they are familiar with them. Thus, consumers are likely to develop positive associations to logos they encounter in various forms throughout their daily lives.

Bibliography

[1] Rucabado-Palomar, T., Cuéllar-Padilla, M. (2020) Short food supply chains for local food: a difficult path. Renewable Agriculture and Food Systems, 35(2), 182–191. https://doi.org/10.1017/S174217051800039X

[2] Rossi, J., Johnson, T., Hendrickson, M. (2017) The Economic Impacts of Local and Conventional Food Sales. Journal of Agricultural and Applied Economics, 49(4), 555–570. https://doi.org/10.1017/aae.2017.14

[3] Syrovátková, M., Hrabák, J., Spilková, J. (2015) Farmers' markets' locavore challenge: The potential of local food production for newly emerged farmers' markets in Czechia. Renewable Agriculture and Food Systems, 30(4), 305–317. https://doi.org/10.1017/S1742170514000064

[4] Diamond, A., Barham, J. (2011) Money and mission: moving food with value and values. Journal of Agriculture, Food Systems and Community Development, 1(4), 101–117. https://doi.org/10.5304/jafscd.2011.014.013

[5] Santos, J. A. C., Santos, M. C., Pereira, L. N., Richards, G., Caiado, L. (2020) Local food and changes in tourist eating habits in a sun-and-sea destination: a segmentation approach. International Journal of Contemporary Hospitality Management, 32(11), 3501–3521. https://doi.org/10.1108/IJCHM-04-2020-0302

[6] Kumar, A., Smith, S. (2018). Understanding Local Food Consumers: Theory of Planned Behavior and Segmentation Approach. Journal of Food Products Marketing, 24(2), 196–215. https://doi.org/10.1080/10454446.2017.1266553

[7] Avianty, S., Khusun, H., Bardosono, S., Februhartanty, J., Worsley, A. (2019) Exposure and approval of food marketing strategies: A mixed methods study among household food providers in Jakarta. Malays. J. Nutr., 25, S47–S62.

[8] Boyland, E. J., Whalen, R. (2015) Food advertising to children and its effects on diet: Review of recent prevalence and impact data. Pediatric Diabetes, 16, 331–337.

[9] Choi, H.; Springston, J. K. (2014) How to use health and nutrition-related claims correctly on food advertising: Comparison of benefit-seeking, risk-avoidance, and taste appeals on different food categories.J. Health Commun. 19, 1047–1063.

[10] Nakandala, D., Smith, M., Lau, H. (2020) Shared power and fairness in trust-based supply chain relationships in an urban local food system. British Food Journal, 122(3), 870–883. https://doi.org/10.1108/BFJ-05-2019-0309

[11] Kaveh, A., Nazari, M., van der Rest, J.-P., Mira, S. A. (2021) Customer engagement in sales promotion. Marketing Intelligence & Planning, 39(3), 424-437. https://doi.org/10.1108/MIP-11-2019-0582

[12] Chiffoleau, Y. (2009) From politics to co-operation: the dynamics of embeddedness in alternative food supply chains. Sociologia Ruralis 49(3), 218–235. https://doi.org/10.1111/j.1467-9523.2009.00491.x

[13] Vecchio, R., Cavallo, C. (2019) Increasing healthy food choices through nudges: A systematic review. Food Quality and Preference, 78, https://doi.org/10.1016/j.foodqual.2019.05.014

[14] Aschemann-Witzel, J. Perez-Cueto, F. J., Niedzwiedzka, B., Verbeke, W., Bech-Larsen, T. (2012) Lessons for public health campaigns from analysing commercial food marketing success factors: A case study. BMC Public Health, 2012, 12.

[15] Ahearn, M. C., Liang, K., Goetz, S. (2018) Farm business financial performance in local foods value chains. Agricultural Finance Review, 78(4), 470–488. https://doi.org/10.1108/AFR-08-2017-0071

[16] Griffith, G., Watson, A. (2016) Agricultural markets and marketing policies. The Australian Journal of Agricultural and Resource Economics, 60(4), 594–609. https://doi.org/10.1111/1467-8489.12161

[17] Martinho V. (2020) Food Marketing as a Special Ingredient in Consumer Choices: The Main Insights from Existing Literature. Foods, 9(11), 1651. https://doi.org/10.3390/foods9111651

[18] Toti, J., Moulins, J. (2016) How to measure ethical consumption behaviors?. Revue Interdisciplinaire Management, Homme & Entreprise, 24(5), 45–66. https://doi.org/10.3917/rimhe.024.0045

[19] Marylaura Acuña, A., Paulien, D., Azzimonti, M., Lariza Castillo, T., Sènankpon, T. (2020) lternative Agri-Food Networks and Their Role in Re-Localization of Food and Creation of Shared Value: The Case of the Leuven Food Hub. Transdisciplinary Insights, 4(1), 182–208. https://doi.org/10.11116/TDI2020.4.9

[20] Wingrove. C. A., Urban B. (2017) Franchised fast food brands: An empirical study of factors influencing growth. Acta Commercii, 17(1), a431. https://doi.org/10.4102/ac.v17i1.431

[21] Chun, T. Y., Lee, D. K.,, Park, N. H. (2020) The Effect of Marketing Activities on the Brand Recognition, Brand Familiarity, and Purchase Intention on the SNS of Franchise Companies. The Journal of Asian Finance, Economics and Business, 7(11), 955–966. https://doi.org/10.13106/JAFEB.

[22] Comanescu, E. L., Ponea-Radu, I. A., Petre-Stan, C., Ponea, G. M. (2018) Competitiveness of Companies in the Competitive Environment – The Essential Question of Performance Management. International conference Knowledge-Based Organization, 24(1), 273–278. https://doi.org/10.1515/kbo-2018-0043

[23] Prasad, R., Jha, M., Verma, S. (2019) A Comparative study of product life cycle and its marketing applications. Journal of Marketing and Consumer Research, 63, 62–69. https://doi.org/10.7176/JMCR/63-06

[24] Florea, D., Claudiu-Cătălin, M., Galvez-Cruz, D., Capatana, G. (2020) The Impact of Product Category Lifecycle and Marketing Capabilities on New Product Performance: the Mediating Role of Marketing Program Planning and Launch Proficiency. Marketing and Management of Innovations, 1, 63–85. http://doi.org/10.21272/mmi.2020.1-05

[25] Berger, P., Chheda, B. K., Minocha, D. (2019) Packaging – an Important Marketing Tool for Brands. GPH - International Journal of Applied Management Science, 2(4), 1–18.

[26] Yeo, S. F. Tan, C. T. Lim, K. B., Khoo, Y. H. (2020) Product Packaging: Impact on Customers' Purchase Intention. International Journal of Business and Society, 21(2), 857–864. https://doi.org/10.33736/ijbs.3298.2020

[27] Florès, L. (2014) The digital market and the main objectives of digital marketing. In: How to Measure Digital Marketing. Palgrave Macmillan, London. https://doi.org/10.1057/9781137340696_2

[28] Rubinfeld, D., Ratliff, J. (2011) Online Advertising: Defining Relevant Markets. Journal of Competition Law and Economics, 6(3), 1–23. https://doi.org/10.1093/joclec/nhq011

[29] Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J. Filieri, R., Jacobson, J., Jain, V., Karjaluoto, H., Kefi, H., Krishen, A. S., Kumar V., Rahman, M. N., Raman, R., Rauschnabel, P. A., Rowley J., Salo, J., Tran, G. A., Wang, Y. (2021) Setting the future of digital and social media marketing research: Perspectives and research propositions. International Journal of Information Management, 59, 1–37.

[30] Appel, G., Grewal, L., Hadi, R., Stephen, A. T. (2020) The future of social media in marketing. Journal of the Academy of Marketing Science, 48, 79–95. https://doi.org/10.1007/s11747-019-00695-1
[31] Finne, Å., Grönroos, C. (2017) Communication-in-use: customer-integrated marketing communication. European Journal of Marketing, 51(3), 445–463. https://doi.org/10.1108/EJM-08-2015-0553
[32] Taken Smith, K. (2019) Mobile advertising to Digital Natives: preferences on content, style, personalization, and functionality, Journal of Strategic Marketing, 27(1), 67–80. https://doi.org/10.1080/0965254X.2017.1384043
[33] Lamberton C., Stephen A. T. (2016) A Thematic Exploration of Digital, Social Media, and Mobile Marketing: Research Evolution from 2000 to 2015 and an Agenda for Future Inquiry. Journal of Marketing, 80(6), 146–172. https://doi.org/10.1509/jm.15.0415
[34] James, D. (2004) Factors influencing food choices, dietary intake, and nutrition-related attitudes among African Americans: Application of a culturally sensitive model. Ethnicity and Health, 9(4), 349–67. https://doi.org/10.1080/1355785042000285375
[35] Li, H. A., Kannan, P. K. (2014) Attributing Conversions in a Multichannel Online Marketing Environment: An Empirical Model and a Field Experiment. Journal of Marketing Research, 51(1), 40–56. https://doi.org/10.1509/jmr.13.0050
[36] Kang, M., Shin, D. H., Gong, T. (2016) The role of personalization, engagement, and trust in online communities. Information Technology & People, 29(3), 580–596. https://doi.org/10.1108/ITP-01-2015-0023
[37] Martin, D. S., O'Neill, M. A., Hubbard, S., Palmer, A. (2008). The role of emotion in explaining consumer satisfaction and future behavioural intention. Journal of Services Marketing, 22(3), 224–236. https://doi.org/10.1108/08876040810871183

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CHAPTER 10

Information systems in agri-food chains

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The aim of Chapter 9 is to learn about the most important characteristics of agricultural information systems and to describe the essence and structure of an agricultural management information system on the market.

The purpose of this chapter is for the reader to:

- Correctly interpret the concept of information systems in agriculture, including the food industry,
- Understand the necessity of corporate application of agricultural information systems,
- Get to know the characteristics of information systems in agri-food chains,
- Review the features of an agricultural management information system on the market.

10.1 Conceptual background of information systems

The existence of information is essential in terms of competitive advantage and in making informed decisions. Those companies that do not have up-to-date, accurate, sufficient quantity and quality information are at a disadvantage, which in the long term worsens the market position and endangers the operation of the company. Recognizing this, the importance of information is constantly increasing and information accessed at the right time and in the right form functions as a resource.

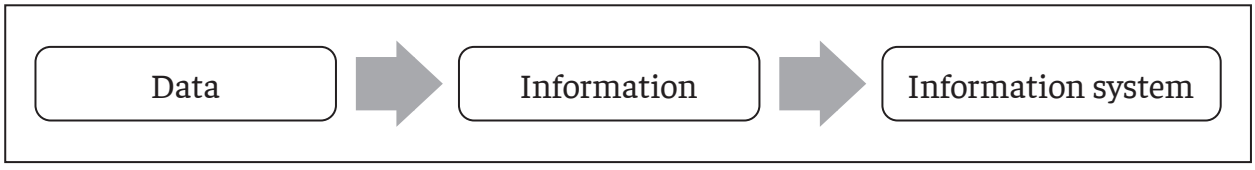

Figure 1. *Procedure of data process*

Information systems are based on data (facts, concepts, instructions) that are suitable for processing and can be interpreted by humans or machines[1]. According to another approach, it can transmit and store the characteristics of already available states, which can thus be used in the future[2]. If we transform these raw facts into a form that can be easily interpreted and used by humans, then we are already talking about

information. In addition to information, information is also new knowledge, clarification, and one of the components of the processes that integrate the operation of companies. Its important characteristic is that it has value, is easy to interpret, reduces uncertainty and helps to make decisions.[3, 4, 5]

Up-to-dateness and high utilization of human resource capacity are becoming increasingly important factors in the market, therefore it is essential that companies can reduce and speed up the time invested in the production of information. There are also opinions that the existence of effective information systems is already considered a condition for remaining on the market[6]. Information systems were created to support these processes, which support the performance of organizational tasks with useful information in a way that creates and processes data and information that serve as basic resources[7, 8]. A set of (technically definable) linked elements that collect, process, store and distribute information and thus facilitate the decision-making, coordination and control of companies[4]. Systems are usually built from components of different qualities and these elements are integrated for end users[9]. In most cases, the information can be created not only in a pre-recorded manner, but also with subjectively selected independent queries, so the system can satisfy if a different need than the previous information needs arises.

The classification of information systems is not uniform, they appear differently in distinct sources, of which Table 1 aims to provide a summary without claiming to be complete.

Table 1. *Possible classification of information systems*

<table>
<tr><th rowspan="2">Based on fit (Krajcsák, 2012)</th><th colspan="2">Based on function</th><th rowspan="2">According to the direction of support (O'Brien & Marakas, 2010)</th></tr>
<tr><th>Based on (Dobay, 1997)</th><th>Based on (Kacsukné Bruckner & Kiss, 2007)</th></tr>
<tr><td>Functional</td><td>Communiational (TPS)</td><td>Transaction processing (TPS)</td><td rowspan="4">Operation supportive:
– Transaction processing (TPS)
– Process controll (PCS)
– Enterprise collaboration (ECS)</td></tr>
<tr><td>Corporational</td><td>Management (MIR, MIS)</td><td>Management (MIS)</td></tr>
<tr><td>Interorganizational</td><td>Decision supportive (DSS)</td><td>Decision supportive (DSS)</td></tr>
<tr><td rowspan="9"></td><td>Management (VIR, EIS)</td><td>Executive (EIS)</td></tr>
<tr><td>Office automation (OAS)</td><td>Enterprise resource planner (ERP)</td><td rowspan="4">Management supportive:
– Management information systems (MIS)
– Decision supportive systems (DSS)
– Executive informational systems (EIS)</td></tr>
<tr><td>Implementation</td><td>Supplier relationship management (SRM)</td></tr>
<tr><td>Groupwork</td><td>Supply chain management (SCM)</td></tr>
<tr><td rowspan="5"></td><td>Expertive (ES)</td></tr>
<tr><td>Enterprise performance management (EPM)</td><td rowspan="3">Operation and management supportive:
– Expertive (ES)
– Knowledge management (KMS)
– Strategical informational (SIS)
– Functional business (FBS)</td></tr>
<tr><td>Business intelligence (BI)</td></tr>
<tr><td>Customer relaionship managing (CRM)</td></tr>
</table>

From the table above, it can be established that, based on their relationship with each other, the simplest systems are created separately only to perform a specific function (e.g. support for the performance of accounting tasks). The integration of several functional information systems is already called a corporate integration system. However, it may also happen that the integration systems of two or more organizations need to be combined, which can be referred to as inter-organizational integration.

Information systems can also be grouped according to function. The groupings shown in the table originate from two different sources, which, although very similar, still show differences, which is why we thought of describing both. We consider it important to draw the reader's attention to the fact that there is different content under the same abbreviation.

According to Dobay, communication systems and transaction processing systems (TPS) are suitable for monitoring organizational events, and can handle the collection and storage of data for various tasks[10]. Management information systems (MIR, MIS) support the provision of information to managers by generating reports. Decision support systems (DSS) help with analysis and modeling tasks. Management information systems (VIR, EIS) support management goals with clearly understandable information. The

data management of office automation systems (OAS) focuses on documents and data and is suitable for handling them. Implementation systems are involved in the value creation process. Group work systems provide group access to databases.

Based on the classification of information systems (Kacsukné Bruckner & Kiss, 2007), we can already find several categories[11]. The transaction processing system (TPS) is no different from the previous ones, it collects and stores data related to everyday business tasks and monitors transactions. The management information system (MIS) in this classification focuses on the information needs of managers, which is supported by the preparation of reports at regular intervals. A decision support system (DSS) is an improved version of an MIS that focuses on a specific problem. The executive management information system (EIS) focuses on the senior management layer, minimizes information needs to the most important factors, the representations are graphic.

The enterprise resource planning system (ERP) supports production planning with related resources, e.g. finance. It usually includes buyer and supplier relationships as well. The supplier relationship management system (SRM) deals with procurement and related suppliers. The primary goal of the supply chain management system (SCM) is to increase the efficiency of the supply chain, e.g. supporting the cooperation of companies in a buyer-supplier relationship. The expert system (ES) has been narrowed down to special fields of expertise. The company's performance management system (EPM) provides, calculates and controls performance indicators. The business intelligence system (BI) is suitable for preparing online analyses. And the customer relationship management system (CRM) not least serves the purposes of customer service and marketing, e.g. customer management.

The third large grouping distinguishes between the direction of support in information systems. Based on this, we can distinguish operation, management and information systems supporting operation and management.

The purpose of the information systems supporting the operation:
- process business events and transactions,
- supervise the processes and
- ensure access to up-to-date data.

The purpose of management support information systems:
- supporting the provision of information to managers,
- acilitating effective decision-making by highlighting usable data.

Information systems that support operations include transaction processing systems (TPS), process control systems (PCS) and enterprise collaboration systems (ECS). While the purpose of the first is to process data from business transactions and update the available databases, the second is responsible for managing and following the processes throughout, and the third supports the necessary corporate collaboration and communication (e.g. e-mail).

Management information systems include management information systems (MIS), decision support systems (DSS) and executive information systems (EIS). MIS can support decision-making with predetermined reports, e.g. production performance. DSS already provides direct support for decision-making, e.g. predicts profitability. Based on MIS, DSS, and other sources, EIS provides information adapted to management needs, e.g. analysis of business performances.

However, there are support systems for both operations and management, e.g. expert systems (ES), knowledge management systems (KMS), strategic information systems (SIS), and functional business systems (FBS). Expert systems provide advice, e.g. in the case of a loan application. Knowledge management systems help the creation and dissemination of business knowledge within the organization, e.g. access to best business practices. Strategic information systems support the company's competitive advantage, e.g. shipment tracking. In the case of functional business systems, the operation of the basic functions of the organization is supported, e.g. accounting applications.

10.2 Information systems in agriculture and the food industry

The need for information is also present in the agricultural sector, and even nowadays it plays an increasingly important role. The spread of digital/smart technologies and solutions is increasingly decisive in this sector as well. Let's see how agriculture is also becoming a "slave" to technology.

10.2.1 Farm-management systems

It can also be seen in the previous chapter that the individual literature sees, treats and groups the information and its areas of utilization differently. One of the reasons for this is, on the one hand, the diversity of tasks and, on the other hand, the different needs of individual sectors. The framework information system that encompasses agriculture is the farm system, the main characteristics of which are: open (it is closely related to its environment), dynamic (changing over time), stochastic (interactions between the elements of the system – people, animals, plants – and the environment) and artificial (man-influenced). Its main goal is to achieve income (yield) from agricultural activity (in money or in nature).

From a farm system perspective, any agricultural system is a purposeful human-made organization composed of five major subsystems these are[13, 14]:

- The technical subsystem in which resources, technology, knowledge and opportunities are used to produce products.
- The organizational subsystem is nothing more than the organizational framework accepted by the official bodies, in which communication, job descriptions, and the distribution of responsibilities and tasks are included in the farm system.
- The informal subsystem already exists if an economy includes two or more persons. The larger the number of people involved, the more complex the informal structural subsystem becomes.
- The goals and values subsystem is related to the goals and values that make the agricultural system work as a purposeful system.
- The management subsystem is connected to the entire farm system. The manager's objectives determine the long- and short-term plans, the creation of the organizational structure, business decisions, technology selection, resource allocation, opportunities, processes through harmonization with the subsystems.

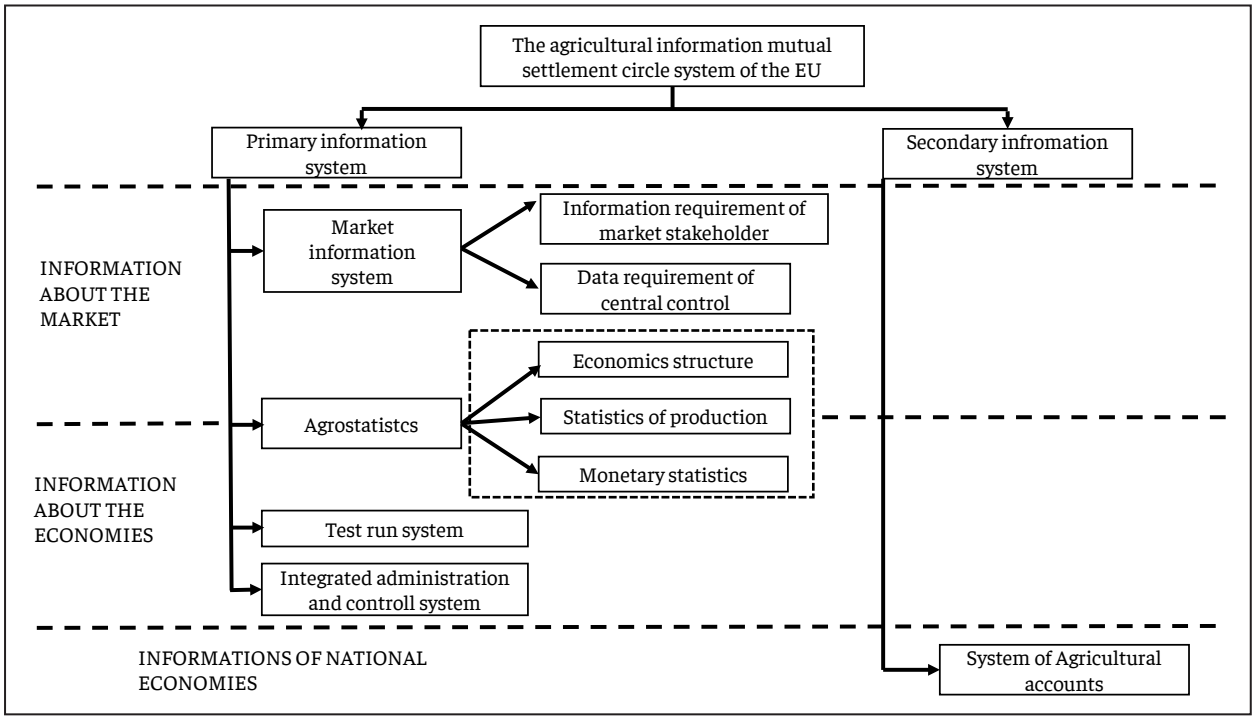

Figure 2. *The Agricultural Information System of the European Union*
Source: Kapronczai[16]

These five subsystems could also be called the building blocks of the farm system. In order to function effectively, management must pay special attention to these integrative processes, which requires properly trained human resources[15].

In the following, let's look at a concrete example of how an information system in agriculture looks and is structured.

The information systems of the EU can basically be classified into two large groups (Figure 2). Primary or prime information systems collect large amounts of direct data. Secondary or subsidiary information systems usually get their information from the databases of the primary systems. The primary data collection - on which the agricultural information system of the European Union is based – can be divided into the following areas: agricultural statistics, FADN (Farm accountancy data network), market information system and the set of information systems for obtaining subsidies.

The promotion of the development of Hungarian agricultural information systems, and as part of this, statistical systems, can be dated around the 2000s due to the EU accession negotiations.

10.2.2 Material and information relations (virtual systems) in the agricultural economy

Based on the previously mentioned systems, the system of relationships of information can be seen, now let's look at what kind of information is needed in the field of agriculture and, perhaps one of the most important things, from whom it can come.

Nowadays, broader and coordinated communication is becoming more and more important in value-enhancing relationships. With the use of technology and other tools, this is forced by the growing competition in the global and domestic markets, the growing needs of different consumers, and the ability to adapt agricultural products to consumer needs[17].

The key factors of the virtual agricultural economy are the groups that manage R&D developments and put information technologies into practice. The point is how we organize them, how we can take advantage of their collective ability. "Agricultural initiatives depend on the skills of professionals and the coordination, integration and management of their tasks."[18] This requires significant relationships, because public institutions and local and regional development agencies must also be partners in economic activities. Figure 3 shows the relationship system of the actors[18].

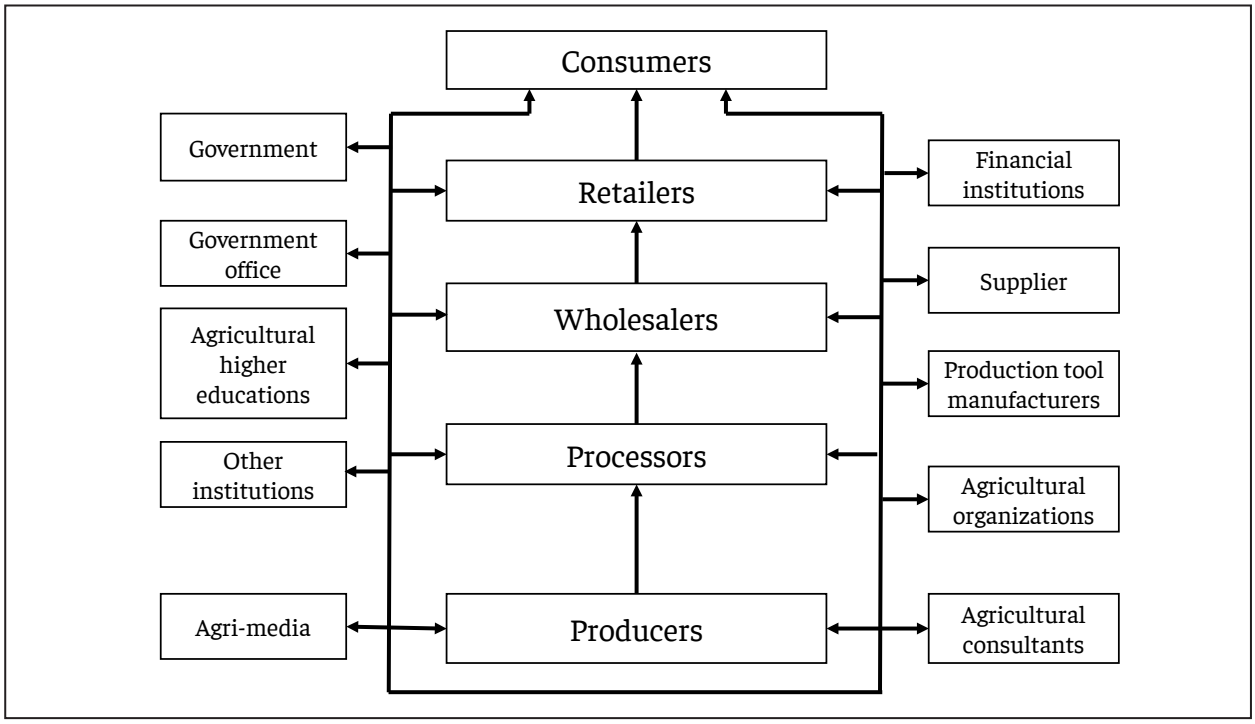

Figure 3. *Material and information relations in the agricultural economy*
Source: Holt and Sonka[17]

10.2.3 Agri-food 4.0

In the next subsection, Agri-Food 4.0 will be presented, that is, how the new digital technology is transforming agri-food supply chains and agriculture.

"Agri-Food 4.0" is an analogy of the term Industry 4.0, which is derived from the concept "Agriculture 4.0". Examining the origins of the industrial revolution, steam engines started the concept of industry, the use of electricity later raised the concept of industry 1.0 to Industry 2.0, and then the use of technologies marked a milestone in the industrial revolution with the concept of Industry 3.0. Industry 4.0 is about incorporating and integrating the latest developments based on digital technologies. This enables businesses to deliver real-time information on behavior and performance. The challenge is to maintain these complicated network structures and connections. These are necessary in order to be able to identify and satisfy the dynamic requirements of parties organized using technologies, especially those interested in the supply chain. In this context, the agricultural field is no exception, although it has some special features depending on the field of expertise.

In fact, all agricultural machinery now includes electronic controls, entering the digital age. In addition, agriculture is supported by electronics, sensors and drones to collect data on many key aspects – such as weather, geographic, spatial location, animal and plant behavior – and the entire life cycle of the farm. However, the application of appropriate methods and methodologies to increase the performance of agricultural supply chains remains a challenge, so the concept of Industry 4.0 has been further developed and adapted to Agriculture 4.0 (which will be explained in more detail below) in order to analyze the behavior and performance of the given area[19]. The appearance of remote-controlled, satellite-controlled machines in the fields or the lack of seasonal agricultural labor will not only use Industry 4.0 technology, but also the application of new varieties and food technologies developed with the help of digitalization and research and development. By integrating production, processing, trade and research and development, new organizational forms appeared in the food industry. The integration of areas with different profitability with helps risk sharing and mitigation as well as creates balanced income. Perhaps these processes help with globalization to ensure that food is provided with environmentally friendly and sustainable agricultural technologies[20].

Adoption of intelligent farming technologies (SFT) in agriculture

Agriculture, one of the important areas of the food economy, is not spared by technological development and innovation. The digitalization of agriculture is considered the fourth (4.0) revolution in agriculture, expressed by the wide range of available digital technologies and data applications. Politicians and experts assume that smart farming technologies (SFT: Smart Farming Technologies) have a significant potential to improve the economic performance of agriculture and contribute to the sustainability of agriculture. This is justified by the fact that they can increase the accuracy of plant and soil input based on site-specific needs, and these aspects can be connected to farm management systems[21].

The agricultural digitization process is driven by the rapid growth in the use of large-scale data. Examples include the further development of existing agricultural technologies (e.g. tractor-based devices that rely on GNSS) as well as applications and software for mobile devices. The purpose of the latter is to connect the data of agricultural production processes (e.g. input quantity and timing) and farm-level work processes and information related to quality management[22].

Fountas et al. currently four general types of technological applications can be distinguished[23]:

- recording and mapping technologies that collect accurate data for subsequent location-specific applications,
- tractor GPS and connected devices that use real-time kinetics for proper application of variable input speed and precise control of tractors,
- applications, farm management and information systems (FMIS) that integrate and connect with mobile devices for easier monitoring and management and
- autonomous machines (e.g. weeding and harvesting robots).

It can be concluded that the technologies that contribute to "smarter" farming are extremely diverse. They benefit cropping practices (reduce the environmental and climate impacts of farming), crop yield (increase soil health) and quality (increase resilience) and farm operations (reduce costs for farmers)[24]. These technologies are called Smart Farming Technology (SFT).

SFT contribute to the sustainability of agriculture as they are able to increase the accuracy of crop and soil use based on site-specific needs and directly link management practices to farm management systems[24, 25, 26], preparing the economies to address labor shortages and climate change[27].

These systems are needed in the long term, because one of the current challenges of production systems is balancing sustainable production with the needs of society or the market. In industrial sectors, certificates are used to reduce the environmental impact of such activities. These are directed to the development of processes in order to become more efficient and to reduce the impact on the environment. Currently, some of these certificates are also used in the European Union, for example ISO 14001 and EMAS (Eco-Management and Audit Scheme)[28, 29, 30].

EMAS is more rigid, more precise, more accessible[28] than ISO, which is why it was chosen by the European Union. The development of sustainability indicators for agriculture is a complex task, which begins with the determination of the parameters to be monitored (soil erosion, soil acidity, production efficiency, among others). The determination of these parameters and the meaning of the indicators can also be influenced by regionality or geographical location, noting that some parameters cannot be uniformly applied in all regions[31].

Sustainability and the agri-food supply chains – challenge, vision

Globalization and free trade policies, as well as consumer demand for safe and high-quality food, have put pressure on the various stakeholders, or key players, in the agri-food supply chain. Impact, contributions, and socio-economic and environmental factors are the most important actors in achieving a successful supply chain flow.

Despite various techniques and conceptual models to make the agri-food supply chain more efficient and profitable, there are still many gaps and new challenges in the supply chain that hinder fruitful, sustainable food production. However, emerging techniques such as traceability and blockchain, food laws and legislation, or the aforementioned conceptual models are expected to contribute to a smoother flow of the agri-food supply chain[32].

The revolution in digital technology has led to a new phase in the field of agri-food technologies. Digital technology has come to the fore and has changed the way people communicate, interact and exchange data in society. Smartphones, smart watches, drones, notebooks, computers, broadband Internet services, etc. are technological innovations that are now known to everyone. Today, the agri-food supply chain is also affected by the digital technological revolution. For example, climate change and its impact on agriculture have been monitored using information and communication technologies (ICT)[33]. ICT is beneficial to global food supply chains as it can provide vital data on innovative techniques for preharvest and postharvest operations[34].

A lot of literature is published on ICT, artificial intelligence, GIS, etc. and their role in the agri-food sector. For example, Wang presented the importance and applicability of e-logistics in supply chain management[35]. The effectiveness of ICT can be best utilized in agricultural trade, extension programs and enforcement of good agricultural practices[36]. Choosing the right planting period, controlling diseases and pests, managing irrigation, managing livestock, choosing the best seeds and plant varieties, and planning storage areas are just a few examples of the role and benefits of ICT in the supply chain. The use of drones in agricultural fields is well known and popular. Sensors are also used to obtain information and meteorological data from isolated or remote rural farming areas. According to Sylvester, sensors can also help preserve highly valued agri-food products[37].

ICT can have direct benefits and help in product identification, food fraud vulnerability, quality and safety measurements, etc. Büyüközkan and Göc ̧er recently proposed an integration framework for the development of a digital supply chain (DSC), with practical applications expected in the near future (Figure 4)[38].

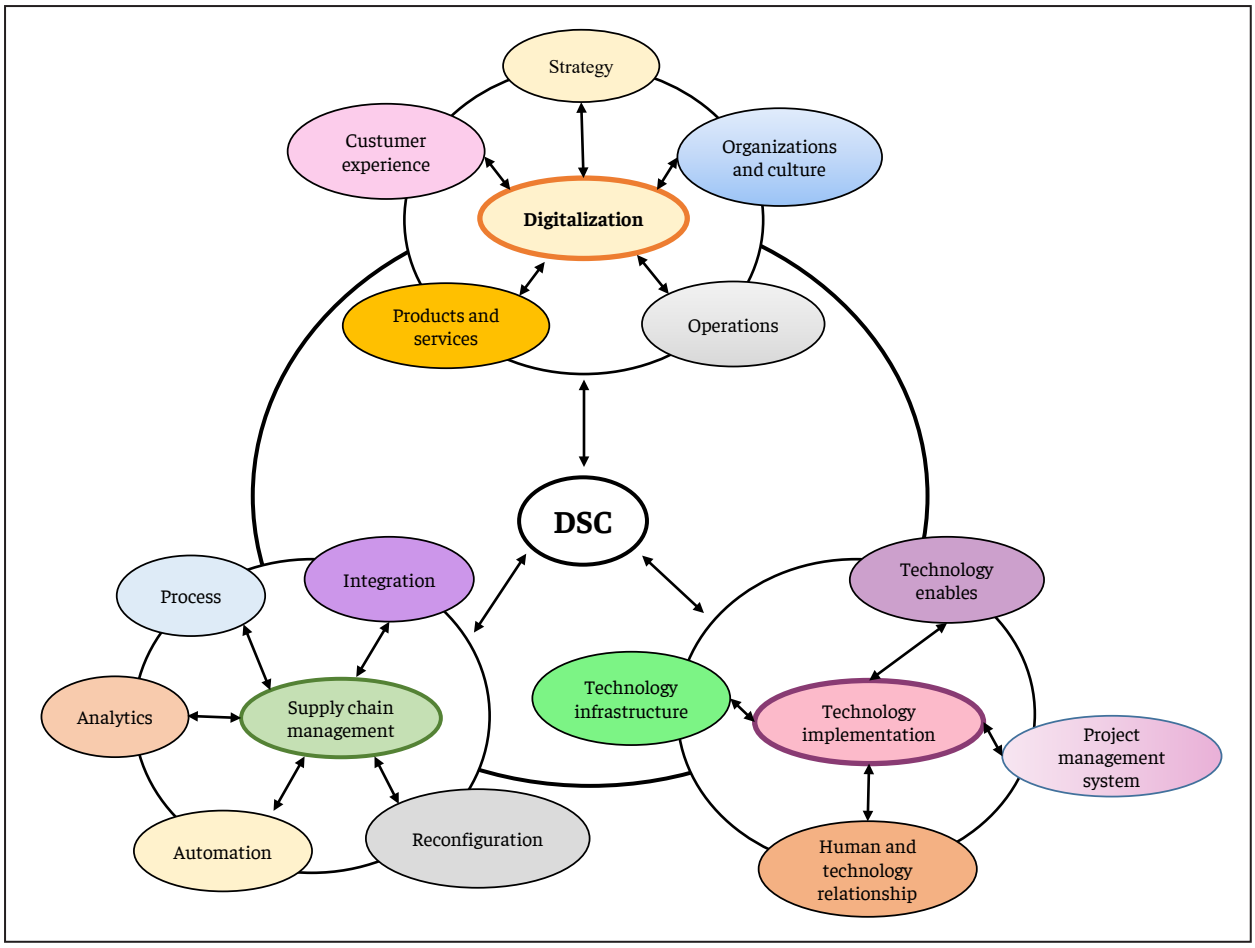

Figure 4. *Integration framework for DSC development*
Source: Büyüközkan & Göc[38]

Some of the popular software developed to identify traceability are Enterprise Quality Management, Food Trak-2 and Qual-Trace. Like other technologies, ICT has its own barriers, such as lack of technical experts and support staff, chances of miscommunication over long distances or in remote regions, lack of access to signals (bandwidth), uncertainty in agri-food in forecasting supply chain trends (demand and supply)[39, 40, 41]. These obstacles must be overcome in the future.

Importance of precision farming

Thanks to the interconnection of agricultural technical and IT developments, the gradual spread of precision farming can be observed. A set of technical, IT, information technology and cultivation technology applications that make production and plant organization more efficient. The main objective of precision farming is to produce high-quality and safe food by using the available resources (forage, water, energy, etc.) as efficiently as possible, all by applying digital solutions. The big question is how to manage in a competitive way, to increase efficiency, while also placing great emphasis on environmental sustainability.

Precision agriculture typically involves the use of state-of-the-art machinery, so the use and maintenance of related machinery and equipment requires appropriate expertise. The introduction of precision procedures requires investment, so small and medium-sized farms can currently only use them to a limited extent. Precision agriculture can offer a solution for mitigating the harmful effects of climate change, feeding the growing population (food quality and crop safety), environmental protection, and sustainability. Precision technologies greatly contribute to sustainable food production, since efficient production also means a reduction in the emission of harmful substances and the ecological footprint of animal husbandry[42].

We have mentioned several times that one of the inherent features of technical developments is properly trained human resources, be it agricultural workers or service IT specialists. Agricultural digitization requires new types of IT professionals. Instead of specialists with traditional, general information technology skills,

specialized IT specialists who know the particularities of the given production and management sector are also needed in many areas of economic life, for example: technical IT, economic IT, or IT agricultural engineer[18]. That is why it is extremely important that the curriculum and quality of the available education is able to follow the rapid changes, because without this, they cannot take place smoothly.

10.3 Possibilities of using a particular agricultural information system

The book chapter – without claiming to be complete – tries to present some good solutions for the practical application of information systems. These software can help the food production enterprises that are the basis of the agri-food chain, therefore, after the theoretical overview, a general farm management software will be presented.

The management information system to be described was created for the registration, control and planning of the production processes of agricultural enterprises. After entering the data, the information that can be extracted is suitable for assisting the work of the family farmer, the manager of a farm of several thousand hectares, the integrator interested in a large area, or the specialist consultant handling the administration of several farms. In addition to the needs of farmers involved in field crop production, it also provides a good solution in the viticulture, winemaking, orchard, horticulture and animal husbandry sectors.[43]

During use, it records, among other things, data related to land areas, knowledge about labor and stocks, stores earth operations, but also provides data to the weighbridge with a direct connection. Aggregated statements and reports can be requested from the modular system. The functions available in each module are detailed in the following subsections.

Registration of land-related data

The main pillar of the information system is the so-called in the cultivation periods module, the register of the land on which the enterprise farms. The cultivation period is a cost collection unit created from the base table, with one culture, one owner, limited in space (hectare) and time (date interval). It is also possible to query the entered data in tabular form per record, or visually displayed on a map.

Related to this, in another, the so-called land issue module, the land owners, the topographical numbers of the land areas, including the ownership shares of the owners, as well as the land lease contracts, are registered. Using the basic data, the software can even make land rent payments, and these payment lists can even be loaded into bank programs as a group and transferred to the land owners at the same time. The topographical numbers can be connected to the tables, i.e. to the cultivation periods, even divided, so that the land rent can also appear as an expense for a given cultivation period. It is possible for the system to calculate and automatically charge the land rent as a cost for the given period, but this cost can also be manually charged to the boards.

The big advantage of the system is that it is able to collect and compare costs and returns, even when broken down to table level. On the one hand, the costs can be collected by recording the work operations (this is the basis of the management diary), in addition to the land rent, the drying fee (e.g. at the time of weighing) can also be charged to a given board within the system, but anything can be entered as other costs.

When choosing the display on the map, the given sign can be placed exactly in the space, which can be a great help not only for the practical specialist but also for the colleagues working in the office. The map can be built from several layers: you can draw topographical numbers or even mepar boards under the table itself (growing period). It can be made e.g. hand drawing, which can be edited and deleted, but ready-made polygons can also be uploaded. By adding a fleet tracking system, the control procedure can be simplified, because it is possible to track exactly where the company's power machine has traveled.

In connection with the map display, by supplementing it with another application, it is possible to precisely track and keep track of and document exactly where and how much a given power machine is working. Thanks to the system, the machine operator can also record his daily activities himself, and the system is able to create a performance-based work operation and worksheet from the resulting data.

In the case of land, it is necessary to mention the land-based subsidy, in connection with which mepar tables can be created with the help of the software. Each mepar board has a parcel identifier, which must be indicated in the payment application for area-based subsidies. In the system, the parcels can be recorded according to the way they appear in the payment request, so that they can be connected to the physically managed fields (growing period). In this way, it is possible to know exactly how much subsidy amount can be used for a given cultivated area, and at the same time a management diary can be produced. Since the size of the cultivated area and the area eligible for support are not always the same, the information system in question also serves well to show the difference between the two.

Records of labor, assets and stocks

In order for the software to be able to calculate costs, it is necessary to record the most important inputs, i.e. tools, stocks and labor. Regardless of the value limit, all machines and assets can be registered in the system, but primarily production assets (power machines, work machines) should be listed here. It is also advisable to record the device that generates general costs, such as the agronomist's off-road vehicle, which does not produce, but its refueling, servicing and other costs are recorded. The general principle is that the more detailed data is recorded, the more the software can help by sending a reminder message, e.g. warning when changing oil. In the case of machines, the sum of diesel, spare parts, service, lubricants and other costs (e.g. insurance premiums, depreciation) and the performance can be used to quotient the settlement price, on the basis of which costs can be shown. These can all be recorded in the system.

In the module for registering the labor, in addition to being able to document the basic data, with the help of lists, e.g. the working hours of the employees or even the wage costs can be reviewed. Based on the work operations, the work performance of the employees can be checked and edited, and on those days where no work hours are displayed due to the lack of work operations, the reason for the absence can be specified (e.g. sick leave, unpaid leave). The system can also warn e.g. in the case of an employee employed in seasonal work, on the 120th day, that the employee concerned has reached the maximum of the legal framework in a given form of employment.

The purpose of these programs is not payroll calculation, but they can be used in proportion to the data to determine the cost of living. It achieves this by calculating an actual cost by the end of the year based on the total cost of the labor given to the company – including gross wages, contributions, cafeteria, telephone and travel reimbursement – and an actual cost can be calculated from the total quotient of actual number of hours which can be used next year as account price in the system.

The quantity and value of stocks become visible in the system, and any stock movement is easy to manage: revenue, sales, use in work operations, listing option (stock inventory statement). Under the stock menu item, you can see all movements related to stocks.

- Inward movement results in monetization, e.g. purchase, or yield, when the produced product can be purchased for stock.
- Outward movement can be achieved through sales, operational expenses (seeds for sowing, pesticides for spraying), scrapping, storage losses, transfer of foreign stock, or re-storage.

Record of work operations

With the help of the interface, the work operations can be recorded, which is the heart and soul of the system, since the operational costs can really be displayed during the cultivation periods. Work operations can primarily be recorded on a board (for the growing season), marking the work operation group itself, recording its total performance, assigning man, power machine, work machine, and, if necessary, the material. When the latter is used, the system also monitors and records changes in the stocks. By recording a work operation, a cost is displayed on the board, we provide information for official announcements (mepar board), performance and cost are recorded for machines and labor, and the stock management module also changes, since the material is removed from the warehouse.

In addition to the table operations, it is possible to record service (repair, maintenance) operations, but operations carried out for an economic unit, i.e. factory operations, can be recorded by selecting the appropriate cost-bearing economic unit, or even wage controlling.

Work operations, as economic events, can be submitted from the system as auxiliary operation dispatches, even broken down to operation level, with the performance of the auxiliary operation and the corresponding value. The system calculates the cost on the basis of operational performance, either by dividing it between the power machine and the working machine, based on their performance, or at the internal settlement price, or, when invoicing, at the external settlement price, based on the information received from accounting.

In the case of precisely guided work operations, it becomes extremely easy to extract the management log, nitrate report, or even the spraying log, which also simplifies the work of the agronomist.

Cooperation between accounting and the agricultural information system

The practical advantage of the information system is that – regardless of the official reports provided by accounting – the decision-maker or the agronomist can see the costs of farming as soon as possible. The program is not intended to replace bookkeeping or payroll, but rather to provide the professional decision maker with information.

With such a system, it is possible to find a common language that both accountants and agricultural professionals understand. It may be good news for accountants that the software can manage both ledger 6 and 7 (as an economic unit) and a given invoice can be broken down to any length and an accounting identifier can be assigned to it. Several accounting identifiers can be assigned to an economic unit, so the software can also handle differences between accounting systems.

The agronomist wants to see different data, and the accounting will provide different data at the end, because while the accounting divides all costs, the agronomist only wants to see costs directly affecting a given area in the system. For example, the specialist is not interested in the general cost of the offroad vehicle, while accounting, among other things, has the task of dividing this between the individual areas.

It is very important for these systems that appropriate basic data is entered, as otherwise the actual cost and the cost itself will be incorrect. If, for example, the operating hours are recorded, an operating log can be kept from this, but not all systems will filter out if something was typed by the basic data recorder.

One of the system's interface connections, the weighscale

The scale module is extremely important from the point of view of the users' stocks recorded in the system. The scale ticket interface shows all the data of the scale ticket: sender, place of sender, identifier (from which table) the product is. The system can even handle special cases when, e.g. two different companies are forced to operate a given board, and one company has a warehouse and weighing house, which the other company does not own. If the crop truck comes in from the field, the system weighs it and distributes it proportionally between the two companies per hectare, thus displaying the amount of garbage and water removed proportionally. At the end of the operation, the crop appears at the storage company as its own property or as a foreign stored product. It is also possible to issue a manual balance sheet in the event of a network connection termination. It is possible to record the drying data, and if necessary, the drying data can also be modified afterwards.

It is also possible to modify the prepared scale notes, while preserving the original scale note.

Not closely, but in connection with the balancing, the crop sales contracts should also be mentioned, which can be recorded in the system, and the scale tickets can be linked to them automatically. In the same way, crop purchase contracts can be recorded, and storage and drying accounts can also be prepared. Of course, it is also possible to issue a scale sheet, based on different aspects: partner income, partner expense, i.e. the system shows the income and expenses of a given partner. The same can be done when measuring wages.

From the point of view of data management, it is a big advantage that the software can completely replace the weighing program so that the program receives the data based on the certified weighing. In this way, the decision maker can see the returns in real time, even immediately. For this, it is necessary that the balance is directly connected to the information system, so the balance software can even be omitted. Both inbound and outbound measurement is possible, but the system owner can also use transfer measurement and wage measurement that does not affect own stock. When delivering crops, it is possible to document which field a given crop came from, so the software can calculate the gross and net yield for it.

Statements

The simplest forms of reports in the system are dashboards, that is, up-to-date graphs that can be customized and displayed on the external interface, which transparently contain the most important metrics for the manager, so that the company's operations can be monitored down to the board-level details. Within the report module, different reports can be created by topic, thanks to the filtering option, in countless versions. In addition to these, Excel format downloads within the system work by sorting and filtering the columns of given items on almost every interface, from which statements can also be prepared.

In addition to all this, the benchmarks – in comparison with the data of other farmers – provide a completely anonymous way of comparison for company actors based on aggregated data. As a basic setting, in addition to the data of the own company's company group, the data of the average system user (that is, the grand average) and the data of the 15 and 3 users deemed by the system to be the best can be displayed. In addition, however – by different filtering options according to needs –, one's own performance becomes visible at the regional level, farm size or e.g. based on annual rainfall.

Some modules of the program can also replace official notifications, since it can produce management logs and spraying logs in (xls) format that meet the legal requirements, but it is also possible to create material in xml format that can be loaded into the system of the General Form Filling Program (GFFP) with the help of the software. The data required for official announcements are recorded, e.g. the fields according to the payment request, thus the master data, are in the system, which simplifies the subsequent work processes and the control process. By reducing document management, manpower can be freed up.

Data quality so-called With the help of the "ADM" indicator, users' data entered into the system, their accuracy and professionalism can be compared, thus the activity can be compared with the activities of other users. A higher value close to 100% indicates more accurate user activity.

Data handling

The company operating the information system pays attention to data security in accordance with the current GDPR regulation, thanks to which no data can be stolen from the system without consequences. Individual users may have different authorizations, as they are granted access to them depending on which modules they use. In addition, every company that uses the software has a system manager who knows as much as possible about the software and who is given system administrator rights at the start. Of course, there is also a level above the company system administrators (the so-called supervisor), which – if necessary – can block possible unauthorized activities and turn modules on and off.

The presented system can be provided to the user in two ways: as a rental right for a predetermined period of time, in which case the user pays a rental fee for the software every month, or as an initial investment cost by paying the license fee, after which an annual supporting fee must be paid. It is important that the data entered into the system are the property of the given economic operator even after the termination of the contract!

Experiences related to the implementation of the investigated agricultural information system

A young researcher investigated the circumstances of the introduction of the information system in the case of two agricultural enterprises from the south of the Danube using in-depth interviews. At the time of the investigation, one company had already used the system for years, while the other had started the implementation process in the year of the investigation.

The training period of the employees took place faster at the company that started implementing the system recently, i.e. in 2020, while the process was slower at the company that started implementing the system earlier (in 2008). This can be explained by the fact that in the years that have passed since then, digitization has undergone significant development, nowadays the use of IT systems is extremely widespread and natural in the everyday life of businesses. As expected, the company that has been using the system for a long time listed more areas of use, which can also be explained by the significant difference in the time of use.

According to company managers, the system significantly facilitates decision-making, as the necessary information is quickly and accurately available to them. Network connectivity, reliability, support, costs, and performance are much more important for businesses than manufacturer reputation.

In the case of both companies, the employees were afraid and distrustful of the new system, but this changed in a positive direction during use. The employees using the system at both companies highlighted the query options according to complex needs as the main factors that make their work easier.

From the results of the research, it can be clearly established that when using the software, managerial decision-making was significantly simplified thanks to the accurate, up-to-date data provided by the system and the useful analyzes that can be made with the system. It also came to light that there are many areas and modules that businesses do not use, even though the system would make it possible.

From the written above, it follows that the introduction of a management information system proves to be a successful investment in the long term, despite the fact that difficulties arise at the beginning of the process due to the many new features.

Bibliography

[1] Kovács, I. (2011) Intergált vállalatirányítási rendszerek, Szent István Egyetem, Gödöllő.
[2] Krajcsák, Z. (2012) Információmenedzsment I., Budapesti Műszaki és Gazdaságtudományi Egyetem, Gazdaság-és Társadalomtudományi Kar Üzleti Tudományok Intézet, Budapest.
[3] Tótfalusi, I. (2001) Idegen szavak magyarul. Tinta Könyvkiadó Kft., Budapest.
[4] Shamsuddin, A., Aziati, N., Hasan, Y. (2014): The Role of Different Types of Information Systems In Business Organizations: A Review. International Journal of Research, Malajzia.
[5] Chikán, A. (2003) Vállalatgazdaságtan. Aula Kiadó, Budapest.
[6] Sadrzadehrafiei, S., Chofrehb, G. A., Hosseini, N. K., Sulaiman, R. (2013) The Benefits of Enterprise Resource Planning (ERP) System Imp-lementation in Dry Food Packaging Industry. Procedia Technology, 11, 220–226. https://doi.org/10.1016/j.protcy.2013.12.184
[7] Sasvári, P. (2012) Az információs rendszerek kisvállalati alkalmazásának vizsgálata. Magyar és Horvátország összehasonlító elemzés. Vezetéstudomány – Budapest Management Review, 43(1. ksz), 56–65. https://doi.org/10.14267/VEZTUD.2012.ksz1.06
[8] Raffai, M. (2003) Információrendszerek fejlesztése és menedzselése. Novadat Kiadó, Budapest.
[9] Westmark, V. (2004) A Definition for Information System Survivability. 37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of the, Big Island, HI, USA, 2004, pp. 10. https://doi.org/10.1109/HICSS.2004.1265710
[10] Dobay, P. (1997) Vállalati információmenedzsment. Nemzeti Tankönyvkiadó, Budapest.
[11] Kacsukné Bruckner, L., Kiss , T. (2007) Bevezetés az üzleti informatikába. Akadémia Kiadó. Budapest.
[12] O'Brien, J. A., Marakas, G. M. (2010) Management Information Systems, 10th Edition, Library of Congress Cataloging-in-Publication Data. New York.
[13] Dillon, J. L. (1992) The Farm as a Purposeful System, Miscellaneous Publication No. 10, Department of Agricultural Economics and Business Management, University of New England, Armidale.
[14] Kast, F. E., Rosenzweig J. E. (1974) Organization and Management: A Systems Approach, 2nd edn, McGraw-Hill Kogakusha, Tokyo., pp. 111–113.
[15] Herdon M., Kapronczai, I., Szilágyi, R. (2015) Agrárinformációs rendszerek, Debreceni Egyetemi Kiadó, Debrecen.
[16] Kapronczai I. (2000) Az agrárinformációs rendszer elemei az EU-harmonizáció tükrében. Statisztikai Szemle, 78(4), 211–224.
[17] Holt, D. A., Sonka, S. T. (2000) Virtual Agriculture: Developing and Transferring Agricultural Technology in the 21st Century, http://www.ag.uiuc.edu/virtagl.html
[18] Herdon, M. (2004) Információtechnológia az agrárgazdaságban. Gazdálkodás, 48(1), 1–13. http://real.mtak.hu/id/eprint/6944
[19] Lezochea, M., Hernandez, J. E., Maria del Mar Eva Alemany Diazc, Panettoa, H., Kacprzyk, J. (2020) Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. Computers in Industry, 117, 103187. https://doi.org/10.1016/j.compind.2020.103187
[20] Egri, I. (2019) Az ipar 4.0 hatása az élelmiszergazdaságra. Jelenkori Társadalmi És Gazdasági Folyamatok, 14(3), 91–101. https://doi.org/10.14232/jtgf.2019.3.91-101
[21] Knierim, A., Kernecker, M., Klaus Erdlec, K., Krausb, T., Borgesb, F., Wurbsb, A. (2019) Smart farming technology innovations – Insights and reflections from the German Smart-AKIS hub, NJAS – Wageningen Journal of Life Sciences, 90–91(December 2019), 100314. https://doi.org/10.1016/j.njas.2019.100314
[22] WoWolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J. (2017) Big data in smart farming – a review. Agric. Syst. 153, 69–80. https://doi.org/10.1016/j.agsy.2017.01.023
[23] Fountas, S., Carli, G., Sorensen, C. G., Tsiropoulos, Z., Cavalaris, C., Vatsanidou, A., Liakos, B., Canavari, M., Wiebensohn, J., Tisserye, B. (2015) Farm management information systems: current situation and future perspectives. Comput. Electron. Agric. 115, 40–50. https://doi.org/10.1016/j.compag.2015.05.011
[24] COM (European Commission) (2017) Communication From the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The Future of Food and Farming, Brussels 29.11.2017, COM (2017)713 final
[25] Walter, A., Finger, R., Huber, R., Buchmann, N. (2017) Smart farming is key todeveloping sustainable agriculture. Proceedings of the National Academy of Sciences USA,114(24), 6148–6150. https://doi.org/10.1073/pnas.1707462114
[26] Müller, H. (2016) Digitalisierung: Wohin geht die Reise. DLG Mitteilungen, (10). pp. S.14–17.
[27] Poppe, K. J., Wolfert, S., Verdouw, C., Verwaart, T. (2013) Information and communication technology as a driver for change in agri-food chains. EuroChoices, 12, 60–65. https://doi.org/10.1111/1746-692X.12022
[28] European Commission (2008) Eco-Management and Audit Scheme Emas – factsheet, 2008, http://www.emas.de/fileadmin/user_upload/04_ueberemas/PDF-Dateien/Unterschiede_iso_en.pdf

[29] European Commission (2018) Emas, a premium environmental management toolfor organisations, 2018, https://ec.europa.eu/environment/emas/pdf/other/EMAS %20presentation%20for%20organisations_2018.pdf
[30] European Commission (2016) Emas and biodiversity, 2016, https://ec.europa.eu/environment/emas/pdf/other/EMAS_Biodiversity_Guidelines_2016.pdf
[31] Freebairn, D., King, C. (2003) Reflections on collectively working toward sustainability: indicators for indicators!, Anim. Prod. Sci. 43(3), 223–238. https://doi.org/10.1071/EA00195
[32] Bhat, R., Jõudu, I. (2019) Emerging issues and challenges in agri-food supply chain. In Sustainable Food Supply Chains, Chains. Planning, Design, and Control through Interdisciplinary Methodologies. Academic Press. pp. 23–37. https://doi.org/10.1016/B978-0-12-813411-5.00002-8.
[33] Ospina, A. V., Heeks, R. (2011). ICTs and climate change adaptation: enabling innovative strategies. In: Strategy Brief 1. Climate Change, Innovations and ICTs Projects, pp. 1–9.
[34] Coley, D. A., Howard, M., Winter, M. (2011) Food miles: time for a rethink? Br. Food J. 113(7), 919–934. https://doi.org/10.1108/00070701111148432
[35] Wang, Y. (2016) E-logistics: Managing Your Digital Supply Chains for Competitive Advantage. Kogan Page, pp. 1–536.
[36] Rao, N. H. (2007) A framework for implementing information and communication technologies in agricultural development in India. Technol. Forecast, 74(4), 491–518. https://doi.org/10.1016/j.techfore.2006.02.002
[37] Sylvester, G. (2013) Information and Communication Technologies for Sustainable Agriculture Indicators From Asia and the Pacific. http://agris.fao.org/agris-search/search.do?recordID1/4XF2017001375 (accessed 26.06.18).
[38] Büyüközkan, G., Göc¸er, F. (2018) Digital supply chain: literature review and a proposed framework for future research. Comput. Ind. 97, 157–177. https://doi.org/10.1016/j.compind.2018.02.010
[39] Huggins, R., Izushi, H. (2002) The digital divide and ICT learning in rural communities: examples of good practice service delivery. Local Econ. 17(2), 111–122. https://doi.org/10.1080/02690940210129870
[40] Smallbone, D., North, D., Baldock, R., Ekanem, I. (2002) Encouraging and Supporting Enterprises in Rural Areas. London: Small Business Service/DTI. http://citeseerx.ist.psu.edu/viewdoc/download?doi1/410.1.1.534.6380&rep1/4rep1&type1/4pdf (accessed 26.06.18).
[41] Deakins, D., Galloway, L., Mochrie, R. (2003) The Use and Effect of ICT on Scotland's Rural Business Community. Scottish Economists Network, Stirling, pp. 1–62.
[42] Erdeiné Késmárki-Gally, Sz. (2020). A precíziós gazdálkodás jelentősége a mezőgazdaság versenyképességében. Multidiszciplináris kihívások, sokszínű válaszok, 2, 43–58. https://doi.org/10.33565/MKSV.2020.02.03
[43] Agrovir felhasználói kézikönyv. In AgriVir program.

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CHAPTER 11

Food legislation of European Union

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11.1 Common Agricultural Policy

The beginning of the development of the Common Agricultural Policy (CAP) can be linked to the Messina Conference (1955) preceding the Treaty of Rome (TR). This is where the idea of a single, common market first arose for the founding member states. Thus, when the Treaty of Rome was concluded in 1957, the goals of the initial CAP were formulated. Initially, the support system as a whole was subordinated to these goals. The goals of the later CAP were recorded in Article 39 of the TR[1]:

1. increasing agricultural productivity through the development of technology, the reasonable increase of production and the optimal use of assets - with particular regard to increasing employment;
2. ensuring a fair level of income for people living in agriculture;
3. stabilization of agricultural product markets;
4. establishing the safety of the food supply;
5. and ensuring that consumers get food at a realistic price.

By achieving the above goals, the agricultural politicians tried to handle the two biggest challenges: to create self-sufficiency in the internal market from basic agricultural products, and to provide a meaningful answer to the basic problems of rural communities, which are the fragmented product structure, the emigration resulting from production difficulties, and the resulting lack of labor was typical.

At the 1958 conference in Stresa, the ministers of agriculture of the member states of the European Economic Community and the actors of the sector agreed on the conceptual elements of the CAP. Thus, the goals generally formulated in the Treaty of Rome were concretized in the three basic principles of common market organizations:

1. the principle of uniformity of agricultural markets,
2. he principle of community preference,
3. the principle of financial solidarity.

The principle of the uniformity of the markets created the completely free movement of goods between the six founding member states. Of course, this also had ancillary elements, such as unified price and competition regulation, a coordinated administrative and health care system, or a common foreign trade policy[2].

Following the conclusion of the conference in Stresa, Sicco Mansholt, Commissioner for Agriculture, was tasked with working out the details of the CAP. The system he developed – which was adopted by the council in 1962 after long discussions – was based on guaranteed prices and joint financing.

The CAP thus became the first and for a long time the only fully integrated policy of the European Economic Community.

The main areas of regulation of the common agricultural policy can be summarized below[3]:

1. common market and price policy: since the national agricultural policies of the 6 member countries differed greatly, the coordination of the regimes was unsatisfactory. Common market organization thus became the first (and until 2000, the only) pillar of the CAP.
2. the aim of the agricultural structure policy is to modernize agricultural production by developing technologies, increasing plant sizes, and supporting agricultural vocational training.
3. harmonization of the legislation applicable to member countries in the fields of public health, animal and plant health issues, taxation, quality and product labeling.

The market regulation of the CAP is based on the Common Market Organizations. Their purpose is to regulate and stabilize agricultural product markets in the long term. The basis of their operation is the principle that internal market prices must always be higher than world market prices, thus ensuring that sufficient quantities of food are always available. Based on the Common Market Organizations, it was given by the system of intervention acquisitions and foreign and domestic market regulation.

On the basis of the above goals and principles, an agricultural policy was formed, which was based on internal market prices higher than world market prices. The high internal market prices stabilized the functioning of the agricultural markets and brought predictability to the sector. At the same time, agricultural supply increased and food security increased. In the sector exposed to risks, the income of producers increased, which led to investments, modernization and increased productivity – thus food security.

The joint regulation aimed at the quality of agricultural products and food began immediately after its establishment. The different food safety and quality requirements of the member states constituted a limitation, practically a technical obstacle, to the free flow of goods. The creation of uniform regulations on the technical quality requirements of food was a very lengthy process. The development of each piece of Community legislation took years, as an unanimous decision in the Council was required[3]. Of course, if a member country feared that the given regulation would be disadvantageous in its own economy, it could prevent the adoption of the proposal.

For some products and product groups, the directive regarding the composition and the production process, which is still valid today, was prepared. This type of regulation of product regulations is called vertical regulation. Regulated products include: cocoa, chocolate, certain types of sugar, fruit juices, jams, jams, quick-frozen vegetables and fruit, mineral waters, coffee extracts, etc.

From the beginning, the horizontal regulation of foods, independent of the type of product, serves to protect the health and safety of consumers. Horizontal regulations apply to a group of products or to the totality of products: for example, the purity of additives, materials and objects in contact with food, labeling of food, official food control, food for special nutritional purposes, genetically modified (GMO) plant products created by biotechnological processes , etc.[3]

11.2 Codex Alimentarius

The international food law, i.e. Codex Alimentarius, is a common reference for consumers, food producers, processors, national food control authorities and international food trade accepted throughout the world. The standardization organization was established in 1962 by two specialized organizations of the UN, the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). It was the goals of the UN standardization program:

- protecting consumers' health and ensuring fair trade,
- promoting the standardization activities of international organizations,

- defining, initiating and managing the priorities of the standardization activity through the relevant organizations,
- development of regional and international standards, where cooperation with other international standardization organizations is possible,
- publication of standards.

Any country that is a member of one of the UN organizations, FAO and/or WHO, can be a member of the Codex Alimentarius. The number of members is currently (2021) 189 countries and the EU as the only organization. Only the member countries have the right to vote, but more than 200 other organizations also participate in the standardization work with consultation rights[URL 1].

11.2.1 Documents of the Codex alimentarius

Codex alimentarius consists of a collection of standards, good practices and guidelines. The documents of the code include the *standards related to specific products,* which describe the characteristics and quality parameters of each product. Most product lines have standards, but regulations do not cover all product groups. The most important regulated groups are the following:

- cereals and their derivatives (e.g. vegetable proteins);
- fats and oils;
- fish, fishing products;
- fresh fruits and vegetables;
- preserved and quick-frozen fruits and vegetables;
- fruit juices;
- meats and meat products;
- milk and milk products;
- sugar, cocoa products, chocolate and other products;
- natural mineral water.

On the other hand, there are *general, horizontal standards* that may also contain product-specific standards. Thus, in addition to the general regulations for all packaged foods, food labeling standards may also contain product-specific provisions. General standards also include standards for the use of additives, standards determining the maximum value of toxins and pollutants. Testing and sampling rules are also prescribed in standards.

Practical standards (Code of Practice) describe the important procedures to be applied throughout the food chain as a whole or in individual areas (e.g. production, transport, catering, etc.). Among these, one of the most well-known and perhaps the most important food hygiene documents is HACCP.

In Guidelines, the Codex Alimentarius Committee lays down principles and policies in certain areas of the food chain (e.g. the addition of essential nutrients to food), as well as the implementation of policies in certain areas (e.g. the labeling of organic food) [URL 2].

11.2.2 Bodies of the Codex alimentarius

The Commission is the main decision-making body of Codex. It defines the goals to be achieved, the principles to be defined and the framework of the concrete standard-setting work. These include long- and medium-term strategies and plans, the development of specific documents, and the approval of materials developed by specialist committees. Similarly to the UN General Assembly, it does not consist of appointed members, but rather a meeting held once a year of the representatives of the member countries. It usually meets in Rome or Geneva. In addition to delegates, observer organizations can also participate in the meetings of the Central Committee.

Between meetings of the Main Committee, the *Executive Committee* manages and supervises the specific work. Its members are elected or appointed. Meets as necessary and prepares the meetings of the Central

Committee. Its members are the chairman of the Main Committee and his deputies, the head of the regional coordination committees (there are six such committees). regional coordinators and one member each from the seven main regions of the world.

The *Secretariat* operating at the FAO headquarters in Rome brings together the operational tasks at many locations. Its task is to resolve frictions between the work of individual committees and to ensure that individual documents and procedures comply with the Codex's strictly fixed procedural rules (Procedural Manual).

Codex documents are developed in many countries of the world, in different bodies (see Figure 1). In *the General Committees*, they deal with horizontal topics affecting the entire food chain (this is why they are also called horizontal committees). There are currently 10 such committees. Each member country undertakes the operation of the specialized committees. The host country provides the secretariats of the specialist committees and organizes the annual meetings. The specialist committees propose the documents to be developed and, if the Main Committee agrees, they carry out their development. *Product committees* differ from general committees in that they deal with one product group each, which is why they are also called vertical committees. After the product committees have established the regulation of a product, they are transformed into the so-called dormant committees. (On the other hand, the work of the General Committees is continuous.) At present, 4 active product committees assist the work of Codex: Codex Committee on Fats and Oils, Codex Committee on Fish and Fish Products, Codex Committee on Fresh Fruit and Vegetables, and Codex Committee on Spices.

Ad hoc Intergovernmental Task Forces differ from specialized committees in that their mandate is for a specific period of time (5 years) and only for the creation of predetermined documents.

Six Regional *Coordination Committees* operate in order to help express and enforce the interests of regions with different levels of development and culture. It is essentially a two-way activity. On the one hand, the individual coordination committees have the opportunity to influence the work going on in the Codex according to their own interests, and on the other hand, they can develop independent documents for their own area[URL 3].

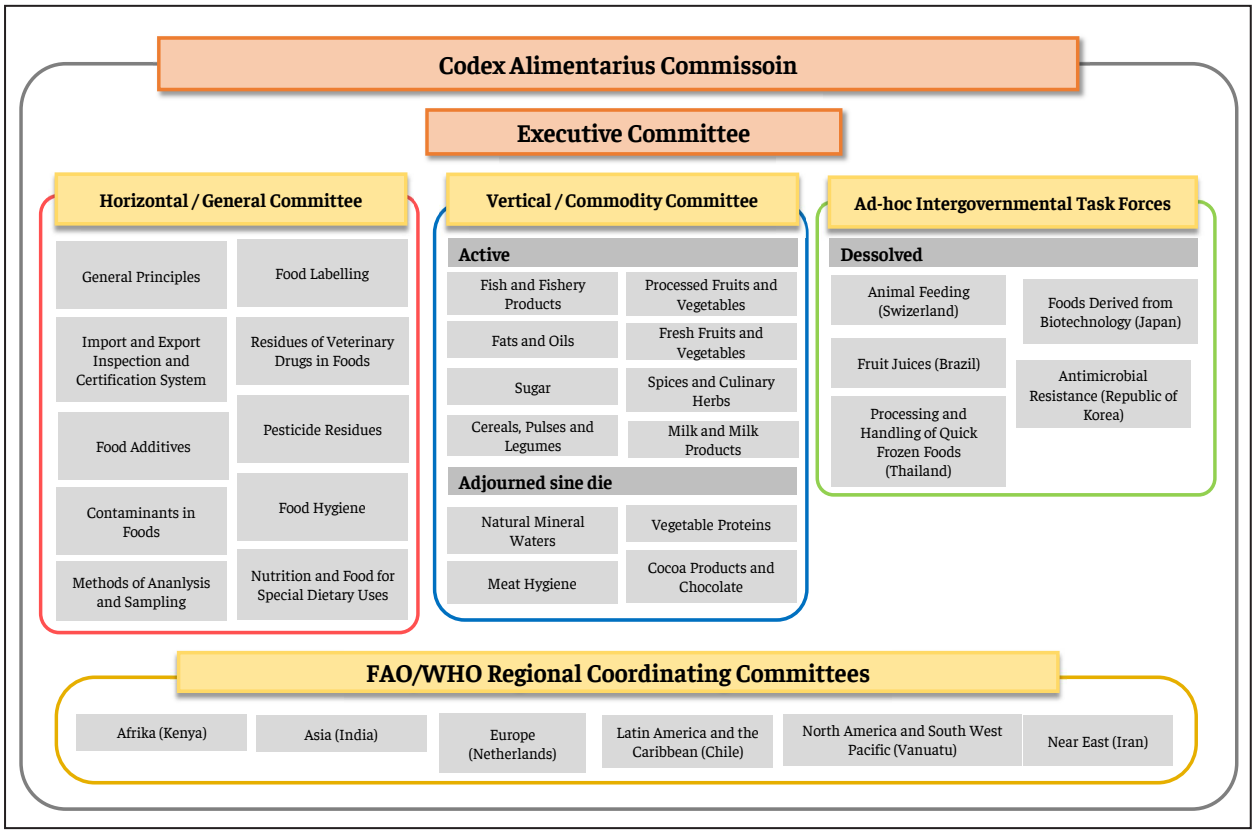

Figure 1. *Organizational structure of the Codex Alimentarius*
Source: Codex Alimentarius Commission Procedural Manual[4]

11.2.3 Working order of the Codex alimentarius

Given that the Codex principle is the pursuit of consensus, the development of documents is a lengthy and complicated process. In all cases, the goal is to create regulations that are acceptable to all regions of the world, Codex member countries and their scientific results, consumers, and producers.

The session, precisely described in the Rules of Procedure, starts with the competent professional committee. The specialist committee makes a proposal to the Executive Committee to start the work. After that, the following labour processes take place:

4. The Main Committee or the Executive Committee examines whether the proposal meets the Codex criteria and priorities and authorizes the work in case of a positive decision.
5. At the Expert Committee meeting, the experts of the member country applying for the task prepare the first draft of the document (proposed draft standard).
6. The Secretariat will send the first draft to all member countries and to the monitoring organization participating in the work of the given committee for their opinion.
7. The draft will be discussed at the meeting of the Expert Committee. This is where they decide on emerging comments, based on which the Secretariat modifies the first draft.
8. The Expert Committee submits the first draft to the Main Committee, who (if it complies with the Codex principles and rules) declares it as planned (draft standard) and authorizes further work.
9. The Secretariat will again send the draft to the member countries and monitoring organizations for comments. If the topic of the draft makes this necessary, the opinion of the relevant Codex General Committees (e.g. marking, analytics, hygiene, etc.) will also be sought.
10. Once again, the meeting of the Expert Committee discusses the opinions sent in writing as well as those that arose at the meeting, and thus concludes the discussion of the draft, and submits it to the Main Committee for approval.
11. The Main Committee decides on the draft. If adopted as a standard, the document becomes part of the Codex Alimentarius document system.[4]

In addition to the above, there is also an *accelerated procedure*, the prerequisites of which are the urgency of the document and a complete consensus on the text during the first draft.

The Order of Procedure allow the specialist committee to set up a *narrower working group* (consisting of a few member states most involved in the debate) to solve each problem of the document.

11.3 The most important elements of EU legal regulation

One of the important cornerstones of joint action in the European Union is the coordination of the rules and provisions of the various member states. We call this process legal harmonisation, which is primarily implemented through various so-called secondary legislation. Secondary legislation is decrees, directives, decisions, recommendations and opinions.

These laws are created and adopted by the various EU institutions, and depending on their type, they are binding on member states or even directly on EU citizens.

The European Union has thus created the foundations for the coherent operation of food safety with its diverse legal activities. This chapter reviews EU legislation related to food safety partly in order of importance and partly in chronological order.

11.3.1 The White Paper on Food Safety

The White Paper, as a type of document, originally means a publication in which the official position of an institution or organization is collected on a specifically defined topic. In EU parlance, White Paper are documents that focus on a certain, strategically important topic and collect the EU's related proposals and draft measures. Their goal is to start a debate.

The White Paper on food safety was published in 2000[5]. The main reason was that the European Commission named the highest level of food safety as a key area, realizing that with the implementation of the single market and the expansion of the Union, the supply chain becomes more complex than anything else. Accordingly, integration in this policy area needed a radically new approach. Effective regulatory environment, risk management and control system.

The White Paper considers the comprehensive and integrated approach, the approach from "producer to consumer" as a basic principle. An important starting point is the principle of clarifying responsibilities, the traceability of feed and food, transparency, risk analysis and precaution, and monitoring. The White Paper already states that an alert system, a food safety authority and a comprehensive food safety ordinance must be adopted.

The document emphasizes research, analysis and scientific cooperation and networks. In a separate chapter, it deals with the issue of control, consumer information and international cooperation. Develops a detailed 84-item action plan to improve food safety. It assigns goals and deadlines to each measure.

This chapter deals in more detail with the general food law regulation, the European Food Safety Authority and the alert system among the ideas of the White Paper.

11.3.2 178/2002/EC – i.e. the so-called general food law regulation

The official name of the regulation to be presented is Regulation 178/2002/EC of the European Parliament and of the Council (January 28, 2002) on the general principles and requirements of food law, establishing the European Food Safety Authority and establishing procedures for food safety. As its name suggests, its purpose is to provide comprehensive regulation to the area under review in response to the demands raised in the previously described White Paper. Its provisions cover food and feed regulations both at the level of the European Union and the member states. Its regulation covers all stages of the production, processing and distribution of the above, but does not apply to products intended for personal consumption (Article 178/2002/EC).

The decree precisely defines the concept of food: "it means any processed, partially processed or unprocessed substance or product intended for human consumption or expected to be consumed by humans." (178/2002/EC Article 2)

The general purpose of the regulation is to ensure a high level of protection of human life and consumer interests. Its basic principles are risk analysis, the precautionary principle and the protection of consumers' interests. According to the precautionary principle, where there is a suspicion that a food may be harmful to health, the European Union takes proportionate and rapid measures. for this, you need a sophisticated risk analysis system, the elements of which are risk assessment and risk management. In both cases, the European Food Safety Authority, to be described later, is assisted by the European Commission as an authentic expert body. As part of the protection of consumers' interests, the Union prevents consumers from falling victim to deceptive practices, food adulteration or other deceptive methods (178/2002/EC Article 5-8).

According to the legislation, unsafe food cannot be placed on the market. Unsafe means harmful to health or unfit for human consumption. In terms of safety, the fact that a food may only have harmful effects for a group of consumers must also be taken into account. The rules are almost exactly the same for feed: the feed is unsafe if it turns out that it is harmful to the health of people or animals or that food produced from animals kept for the purpose of food production is unsafe for human consumption. It is necessary to check and enforce the above rules throughout the entire food chain, therefore the order stipulates that the traceability of all material paths must be ensured at every stage of production, processing and distribution. The Union imposes obligations on food and feed industry entrepreneurs to ensure that their products fully comply with the prescribed requirements. If the entrepreneur believes that a food or feed does not fully meet the requirements, he must immediately inform the authorities and initiate the withdrawal of the product from the market. In addition, you have a full obligation to cooperate with the authorities.

The member states are responsible for enforcing food law and organizing inspections. Food is safe even if it comes from outside the EU, as food and feed imported into the EU for marketing must meet the require-

ments of food law or conditions recognized by the EU as equivalent to the provisions of EU legislation (178/2002/ Articles 11-21 EC).

The decree deals with crisis management and emergency situations in a separate chapter. It lists item by item which measures can be taken in the event of an emergency: suspending the placing on the market of the food or feed in question, defining special conditions applicable to them. They can do this both for products from within the EU and from third countries. In addition to immediate reactions, the regulation requires the European Commission and EFSA to prepare a general crisis management plan (178/2002/EC Articles 53 - 57).

The aforementioned decree also established the European Food Safety Authority (EFSA) and the European Union's Food and Feed Safety Alert System (RASFF). More about these institutions can be found in section 13.5. will be discussed in chapter.

11.3.3 Other legislation

As we have seen, Regulation 178/2002/EC only provides the general but very important framework for the legal regulation of food safety. At the time this chapter was prepared, the collection of EU legislation contained 3,688 different documents related to the topic.

Table 1. *EU documents adopted on the topic of food safety*

Legal act	**1819**
International agreement	314
Preparatory document	567
Parliamentary question	878
Judicial practice	78
EFTA document	8
Other	24
TOTAL	3688
ÖSSZESEN	**3688**

Source: own editing based on Eur-lex.europa.eu [URL 4]

The rules dealing with the topic of food safety are very diverse and it is clear from the table above that we are talking about thousands of rules, so it is advisable to present which topics are affected by the adopted documents.

The materials are grouped around three broad themes: food, animal health and plant health.

Foods

The general rules for foods apply to the distribution, information, authorization of various products and their importation into the Union. Sampling and testing methods for checking the levels of certain elements in food are defined. Countless laws deal with food labeling and nutrition labeling, separate rules apply to different food groups, such as fruits, quick-frozen foods, etc. The European Union also places great emphasis on the regulation of dietary supplements, natural mineral waters, and foods intended for specific groups (medical foods, formulas, etc.).

The so-called new foods form a separate category. There are accepted laws on nutrition and health claims as well as on food additives (e.g. additives, smoke flavors, enzymes, etc.). Part of the legislation deals with biological and another part with chemical safety.

These categories include, for example, food hygiene, food irradiation, pollutants, other substances in food, or regulations dealing with the hormone content of meat. When it comes to regulating food production, the Union deals with regulations on feed, such as also with feed hygiene, feed additives, medicated feed and genetically modified feed[URL 5].

Animal health

An important prerequisite for food safety is that the health and well-being of animals intended for human consumption are regulated in sufficient detail, thus minimizing the risk. Accordingly, the animal health rules deal with the following relevant topics: zoonosis, animal diseases (African horse sickness, swine fever, foot-and-mouth disease, bird flu, bluetongue disease, transmissible spongiform encephalopathy), the implementation of EU rules on the agri-food chain or the system of official controls. The European Union has also adopted an animal welfare regulation, the rules of which cover the breeding, transport and slaughter of animals.

Separate rules apply to both the trade and import of live animals and animal products. as part of this, rules on animal health border control were also created[URL 6].

Plant health

Three large groups of phytosanitary regulations can be linked to food safety. These:

- legislation on genetically modified organisms
- legislation on plant protection products
- regulations related to plant health and biological safety[URL 7].

To get to know the detailed rules, it is worth using the database of the European Union's legislation, which is up-to-date and provides detailed search conditions to guide us through the rules[URL 8].

11.4 The EU institutional system of food safety

Based on the ideas of the White Book on food safety, Regulation 178/2002/EC presented in the previous chapter established the European Food Safety Authority (EFSA) and also provided for the establishment of an alert system. These institutions are presented in the following subsections.

11.4.1 European Food Safety Authority (EFSA)

The European Food Safety Authority (EFSA) was established by the General Food Law Regulation. Its main task is to provide scientific advice and provide scientific professional assistance to European Union decision-makers in areas under EFSA's competence. In addition, it collects and provides information, collects and analyzes data. This enables the description and monitoring of risks affecting food and feed safety (Article 22 of 178/2002/EC). Its seat is located in Parma, Italy. Areas covered by EFSA:

- food and feed safety,
- nutrition,
- animal health and welfare,
- plant protection,
- plant health[URL 9].

It is clear from the decree that the Authority's task is of a scientific nature. Its credibility is also guaranteed by its mandatory independence. Its activities can be grouped around five major tasks:

1. scientific data collection and analysis,
2. preparation of scientific opinions,
3. information,
4. cooperation with other EU institutions and national authorities,
5. increasing confidence in the food safety system.

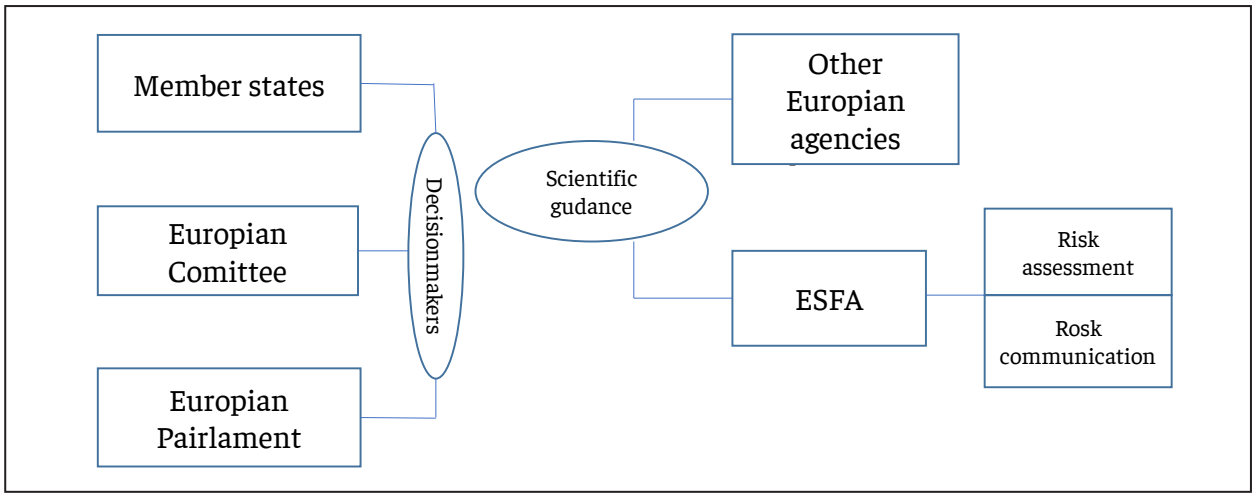

Figure 2. *The Authority's relationship with EU institutions and member states*
Source: Based on EFSA[6]

The main organs of the Authority are the Board of Directors, the Managing Director, the Advisory Forum, the Scientific Committee and other scientific bodies.

Board of Directors
The Board of Directors consists of 15 members, four of which come from consumer protection organizations or other advocacy organizations active in the food chain. The appointment of members is for four years, which can be extended once. As usual in the European Union, the mandate of the head of the unit is half of the mandate of the organization, i.e. the members elect a president from among themselves for two years, who can also be re-elected. The board can be convened by the president or at least one third of the members, decisions are made by majority vote. Its main tasks are to adopt the internal regulations, financial regulations and annual work program of the Authority. With all of this, the Board of Directors ensures that the Authority fulfills its mission and carries out its tasks according to the conditions set out in this regulation (Article 25/EC 178/2002).

Executive Director
The executive director embodies the entire authority in one person and acts as its representative. His tasks include ensuring the daily activities, proposing to the Board of Directors the work program and budget of the Authority, and implementing the decisions of the Board of Directors. It supports the work of organizational units, such as the Scientific Committee and scientific bodies. During the implementation of the budget, the executive director prepares the profit and loss statements, decides on personal matters and is responsible for maintaining relations with the European Parliament, the European Commission or even the Member States (Article 26 of 178/2002/EC).

Advisory Forum
As indicated in the name of the Consultant's forum, its main task is to provide advice to the Executive Director in the performance of his duties. This is mainly done during the preparation of the annual work program. Its members represent Member State institutions with a similar task to that of EFSA. Members of the Forum cannot be members of the Board of Directors. An important function of this unit is that, as a collection point of available information, it has a key role in the exchange of information related to risks (Article 27 of 178/2002/EC).

The Scientific Committee and scientific bodies
Both the Scientific Committee and the scientific bodies are the main custodians of the professional work, since each of them is responsible for preparing expert opinions. Scientific bodies consist of independent experts According to the general regulation, the following scientific bodies must be established:

- scientific body for food additives and flavorings, food processing aids and food contact materials;
- scientific body of additives, products and materials used in animal feed;
- scientific body for plant health, plant protection products and their residues;
- scientific body of genetically modified organisms;
- scientific body for dietary products, nutrition and allergies;
- scientific body of biological hazards;
- scientific body of pollutants entering the food chain;
- scientific body of animal health and animal protection.

The members of the Scientific Committee are the presidents of the above scientific bodies and six independent scientific experts who do not belong to the scientific bodies. The Commission has a president and two vice-presidents, who are elected from among their members. Their decisions are made by majority vote (Article 178/2002/EC, Article 28). Figure 3 illustrates the relationship between the individual bodies of EFSA:

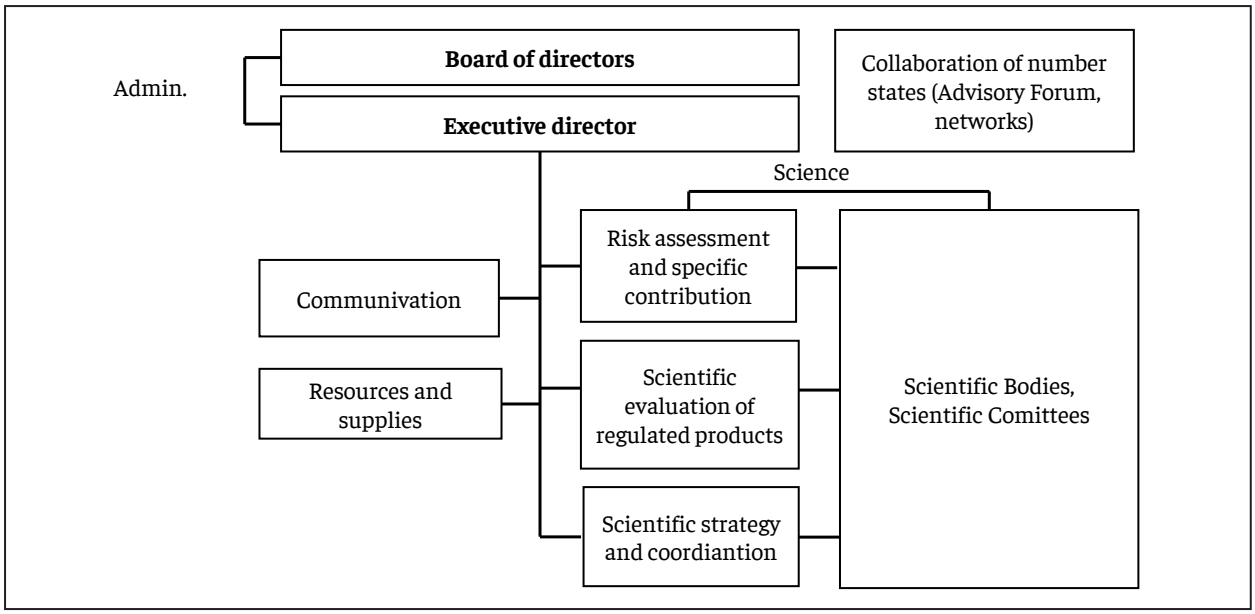

Figure 3. *The relationship of some of EFSA's bodies to each other*
Source: Based on EFSA[6]

The figure shows that the scope of administrative and scientific tasks within the Authority is clearly separated from each other. The membership of the scientific bodies and the Scientific Committee is renewed every three years.

As we saw when presenting the legislative environment, there is a clear demarcation of tasks in the European Union with regard to health and safety issues affecting people, animals and the environment. accordingly, EFSA works closely with other EU agencies by name:

- European Medicines Agency (EMA)
- European Chemicals Agency (ECHA)
- European Center for Disease Prevention and Control (ECDC)
- European Environmental Protection Agency (EEA)[URL 9].

11.4.2 The European Union's food and feed safety alert system (RASFF)

The establishment of the Rapid Alert System for Food and Feed (RASFF) operating in EU member states was also required by Regulation 178/2002/EC, although the system had been operating in a similar form since 1979[URL 10]. The cited decree only defines the framework, according to which the goal is to create a system that functions as a network and can signal in the event of a danger directly or indirectly affecting human health arising from food and feed. Within the RASFF, the alarm chain starts with the hazard detector. The

information is first sent to the European Commission, which immediately informs all members of the network. EFSA's task in this chain is to provide additional scientific or professional information so that the Member States can take appropriate risk management measures as soon as possible. Let's examine in more detail in which cases the system indicates:

- When Member States restrict the placing on the market of certain food or feed, withdraw it from the market or recall it in order to protect human health
- when the member state makes a recommendation or an agreement, the purpose of which is to prevent, limit, or subject to specific conditions the placing on the market and use of food and feed that pose a risk
- when a shipment is turned back by the competent authority at a border crossing point in the territory of the European Union due to a health risk (Article 50 of 178/2002/EC)

The detailed rules of operation are contained in Regulation 16/2011/EU, adopted in 2011, "on the establishment of enforcement measures for the food and feed safety alert system". Pursuant to the decree, the members of the RASFF are, in addition to the EU member states, the European Commission, the EFSA and any country, third country or international organization that has signed an agreement with the European Union. Currently, the non-EU members of the system are Liechtenstein, Norway and Switzerland.

Announcements can be classified into four groups according to their level of risk and urgency:

1. Alarms: highest risk, immediate action is required
2. Information: does not require immediate intervention from all Member States, as the risk only exists in the reporting country
3. Notifications about turning back at a border crossing point
4. Additional notifications: additional information received for previous alerts[URL 11].

RASFF creates a database of public notices, and the European Commission also prepares an annual report from them, which is available to everyone.

11.5 The *Farm to Fork Strategy* as a comprehensive approach

The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050. One of the most important elements of this Agreement is the Producer-to-consumer strategy for a fair, healthy and environmentally friendly food system (hereinafter referred to as the Strategy), which comprehensively addresses the challenges of sustainable food systems, taking into account the inseparable relationship between healthy people, societies and the planet. The Strategy is an integral part of the EU Commission's efforts to achieve the sustainable development goals of the UN. According to the Commission's point of view, the transition to a sustainable food system will bring environmental, health and social benefits, as well as economic benefits. The focus of the Strategy is the implementation of a solid and resilient food system, which is functional in all circumstances and is capable of providing people with access to food of adequate quantity and quality.

Thanks to several decades of policy decisions aimed at this, as well as the efforts of farmers and participants in the product pathways, today the European food supply is safe and abundant in the world, and the food produced is nutritious and of high quality.

The goal of the Strategy is for European food to become a global standard of sustainability, to this end reward those actors (farmers and other actors in the food chain) who have already switched to sustainable practices and encourage others to follow the good example. This gives EU players a leg up on the global market.

The Farmland to Table Strategy aims to accelerate the transition to a sustainable food system that:

- has a neutral or positive impact on the environment;
- helps to neutralize climate change, but is able to adapt to its effects;
- helps improve biodiversity;

- implements food and nutrient security, improves the public health situation, by ensuring everyone has access to the right amount of safe, nutritious and sustainably produced food;
- ensure food affordability while generating fairer economic returns, promote the competitiveness of the European Union supply sector and promote fair trade.

According to the principle of the Strategy, all actors in the food chain must participate in achieving the sustainability of the food chain. Agricultural producers must transform their production methods as quickly as possible and take advantage of nature-based, technological and digital solutions to achieve better environmental and climate results, increase resilience against the effects of climate change, and reduce the use of input materials (e.g. pesticides, fertilizers) in order to reduce and optimize.

It encourages the development of new green business models, the circular bio-based economy, and the development of renewable energy production. According to the plans, the use of traditional plant protection agents will be reduced by 50% by 2030, while helping the spread of alternative solutions, prioritizing integrated plant protection.

Measures are taken to reduce air, soil and water pollution, which is one of the motors of climate change problems. To this end, it is necessary to reduce the excessive use of nitrogen and phosphorus in agriculture. A 50% reduction in nutrient loss can be achieved with a 20% reduction in fertilizer use, the necessary steps for this will be included in an integrated nutrient management action plan.

It is a problem that more than 10% of the EU's greenhouse gas emissions come from agriculture, and animal husbandry is responsible for nearly 70% of this. In addition, 68% of the agricultural land is used for animal husbandry, so alternative feed materials (e.g. insects, algae) come to the fore in order to reduce dependence on critical feed materials.

Animal welfare measures will be prioritized and innovations in this direction will be supported to combat plant health problems arising as a result of climate change.

A prominent part of the Strategy is the question of food security, since climate change and the reduction of biological diversity pose a direct and lasting threat to food security. Factors affecting the sustainability of food systems do not necessarily originate from the food supply chain itself, but can also be caused by political, economic, environmental or health crises.

Common European responses to these problems are necessary. In addition to this, the Strategy focuses on improving the food consumption structure and educating consumers on healthy and sustainable consumption. The aim is to make sustainable food available and at the right price on the European market, in order to reduce food waste and food fraud[7].

11.6 Case studies

In this subsection, we present some cases that prove the need for an EU regulatory system in the field of food safety.

BSE – spongiform encephalopathy

BSE, i.e. spongiform encephalopathy, is a latent destruction of the brain and central nervous system that always ends in death. It came to be known colloquially as "crazed cattle disease". Its human version is Creutzfeldt-Jakob disease. It has not yet been proven that the BSE pathogen can be transmitted from animal to animal, but during the British BSE crisis, a new version of Creutzfeldt-Jakob disease also appeared[8]. Cases have been detected in the UK since the 1980s, but panic broke out when the first case of BSE was documented in Germany.

In response to this, the EU introduced a ban on the use of feed containing animal protein in 2001, which drastically reduced the incidence of BSE. The European Commission has asked the European Food Safety Authority (EFSA) to continuously investigate the cases. EFSA experts made several proposals for maintaining and strengthening the EU monitoring and reporting system, as well as for evaluating newly available scientific data[9].

Bird flu

Avian influenza is a disease caused by the influenza virus that can live in the body of birds. Its most dangerous variant is HPAI (highly pathogenic avian influenza). It first appeared in Italy, now it occurs all over the world. So far, it has only spread from person to animal in a few cases, and its variant that spreads from person to person is not known. EFSA continuously monitors EU member states and prepares regular reports on reported HPAI cases. In the course of this, they investigate the species in which the disease occurred and whether genetic markers can be identified in the virus that would allow it to adapt to mammals[10].

Listeria contamination

In 2018, the ESFA warned about the dangers of frozen vegetables packed by a Hungarian company, which caused many illnesses and 9 deaths across Europe[11]. During packaging, Listeria monocytogenes entered the food. During the traceability of the food, the manufacturing company and the period when the affected quick-frozen vegetables were produced were also identified. The majority of signals to the RASFF system are directed to Listeria monocytogenes contamination after Slamonella contamination. ESFA experts examined the cases and made recommendations for safe food.

Aflatoxin

Aflatoxins are naturally occurring mycotoxins that are also dangerous to humans. Molds produce them. They are mainly found in cereals, but in Hungary in 2004 hot peppers contaminated with aflatoxin caused serious problems[URL 12]. At the request of the European Commission, EFSA prepared a risk assessment in 2020 regarding aflatoxin contamination of food. The authority concluded that the occurrence of aflatoxin should continue to be monitored in light of the potential increase due to climate change[12].

Bibliography

[1] Vertrag Zur Gründung Der Europäischen Wirtschaftsgemeinschaft (1957) April, 176. https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:11957E/TXT&from=EN

[2] Jámbor, A., Mizik, T. (2014) Bevezetés a Közös Agrárpolitikába. In Bevezetés a Közös Agrárpolitikába. Akadémiai Kiadó, Budapest. https://doi.org/10.1556/9789630597869

[3] Halmai, P. (2020) A Közös Agrárpolitika rendszere. DialogCampus.

[4] FAO/WHO (2018) Codex Alimentarius Commission Procedural Manual 26th edition. www.codexalimentarius.org

[5] Európai Bizottság (2000) Az élelmiszerbiztonságról szóló Fehér Könyv.

[6] EFSA (2012) Science protecting consumers from field to fork.

[7] Európai Unió (2020) A „termelőtől a fogyasztóig" stratégia a méltányos, egészséges és környezetbarát élelmiszerrendszerért. COM(2020) 381 Final, 24. https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0011.02/DOC_1&format=PDF

[8] Honikel, K.-O. (2001) BSE-válság. Az Európai Unió Agrárgazdasága, 6(3), BSE-VÁLSÁG (mezogazdasagikonyvtar.hu)

[9] Nébih (2017) Szarvasmarhák szivacsos agyvelősorvadása: az EFSA szakértői az elszigetelten megjelenő BSE-megbetegedések okát vizsgálják. https://portal.nebih.gov.hu/nebih_wire_sajtoszoba/-/asset_publisher/J3lwUyoN2WOk/content/altalanos-ismerteto-a-rasff-rendszerrol/maximized

[10] EFSA (2020) Avian influenza overview – update on 19 November 2020, EU/EEA and the UK

[11] Szalai (2018) 9 halálesetet okozott a magyar cég. Index, 2018. 07. 05. https://index.hu/gazdasag/2018/07/05/9_halalesetet_okozott_a_magyar_ceg/

[12] EFSA Panel on Contaminants in the Food Chain (CONTAM): Bignami, M., James, B., Chipman, K., del Mazo, J., Grasl-Kraupp, B., Hogstrand, C., Hoogenboom, L., Leblanc, J.-C., Nebbia, C. S., Nielsen, E., Ntzani, E., Petersen, A., Sand, S-, Schrenk, D., Schwerdtle, T., Vleminckx, C., Wallace, H. (2020) Scientific opinion – Risk assessment of aflatoxins in food, EFSA Journal, 18(3), e6040. https://doi.org/10.2903/j.efsa.2020.6040

Online sources

[URL 1] http://www.fao.org/fao-who-codexalimentarius/about-codex/members/en/

[URL 2] https://elelmiszerlanc.kormany.hu/download/6/6b/40000/A%20Codex%20dokumentumok%20fajt%C3%A1i_Pn%C3%A9.pdf

[URL 3] https://elelmiszerlanc.kormany.hu/codex

[URL 4] https://eur-lex.europa.eu/

[URL 5] https://eur-lex.europa.eu/summary/chapter/3010.html

[URL 6] https://eur-lex.europa.eu/summary/chapter/3011.html

[URL 7] https://eur-lex.europa.eu/summary/chapter/3012.html
[URL 8] https://eur-lex.europa.eu/summary/chapter/30.html
[URL 9] https://europa.eu/european-union/about-eu/agencies/efsa_hu
[URL 10] https://ec.europa.eu/food/food/rasff-food-and-feed-safety-alerts_hu
[URL 11] https://portal.nebih.gov.hu/nebih_wire_sajtoszoba/-/asset_publisher/J3lwUyoN2WOk/content/altalanos-ismerteto-a-rasff-rendszerrol/maximized
[URL 12] https://hu.wikipedia.org/wiki/Aflatoxin

Measurements, legislations

[1] A Bizottság 16/2011/EU rendelete (2011. január 10.) „az élelmiszer- és takarmánybiztonsági riasztási rendszerre vonatkozó végrehajtási intézkedések megállapításáról
[2] Az Európai Parlament és a Tanács 178/2002/EK rendelete (2002. január 28.) az élelmiszerjog általános elveiről és követelményeiről, az Európai Élelmiszerbiztonsági Hatóság létrehozásáról és az élelmiszerbiztonságra vonatkozó eljárások megállapításáról

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CHAPTER 12

Conventional and alternative financial supports

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12.1 Importance of financing in the life of agricultural enterprises (investment and working capital financing)

Financing sources are necessary for the establishment, operation and growth of the enterprise. The purpose of the financing decisions is to satisfy the capital requirement for the company's investments, as well as to provide the capital necessary for operation on an ongoing basis.

Financing decisions are influenced by many factors:

- Duration of resources availability. How long are the funds available, and what schedule must be used to repay the money?
- The cost of the resource. How much does it actually cost to raise a particular source of funds, and does the business's ability to generate income allow repayment?
- The risk of raising funds. What risks will the business be exposed to if it uses a particular source?
- Availability of the source. What is the range of resources available to the business?
- Flexibility of the source. Does the resource match the fluctuations?
- The influence. To what extent does the involvement of the given source hinder the entrepreneur in managing the business?

A wide range of financing options are available in the financial markets. A thorough consideration is required before a financing decision is made. In order to find the right form of financing, it is worth considering the following basic principles:

- Principle of profitability: the profitability of the investment realized from the source must exceed the cost of the source involved.
- Safety principle: the company's operation and turnover cannot be hindered by repayment obligations.
- Principle of flexibility: capital needs must be managed flexibly in accordance with fluctuations.

- Principle of normativity: in order to obtain foreign capital and assess creditworthiness, they start from certain standards that must be met.
- Liquidity principle: the conditions of the debt service obligation must be ensured.

By the financing, source or capital structure of a company, we mean the composition of the financing sources used. When establishing the company's funding structure, it is recommended to pay special attention to compliance with the principle of maturity matching. The maturity matching principle states that it is necessary to finance permanently fixed assets from permanent sources, and temporarily fixed assets from temporary sources. We can talk about financing balance if the balance sheet complies with the matching principle, which is illustrated in the figure below:

TOOLS	SOURCES
Fixed assets	Sustainable resources (equity and long-term liabilities)
Preservation of fixed assets	
Temporary working capital tie-up	Short-term liabilities

Figure 1. *Funding balance*
Source: own editing

Depending on whether a company adheres to the matching principle or deviates from it, three types of financing strategies can be distinguished[1]:

- Solid strategy: the company adheres to the principle of maturity matching.
- Conservative strategy: the company finances even part of the temporary asset needs with permanent resources. The advantage is safety, the disadvantage is higher cost.
- Aggressive strategy: The company also uses short-term funds to finance durable assets. It's a risky, but much cheaper solution.

One of the important tasks of the entrepreneur is to raise the funds necessary for operation. In the case of startups or businesses with high growth potential, the need for financing sources is even more significant. Small and medium-sized enterprises (SMEs) are characterized everywhere by low capital availability and limited internal financing options. Their own fundraising possibilities are more limited due to the narrow range of owners and their own accumulation capabilities are also weaker. In addition to their low risk-taking, their external involvement of sources is also limited by the fact that they themselves pose a high risk to their financiers. Although the planning activity of SMEs has improved in Hungary in recent years, planning deficiencies and even the lack of business/financial plans themselves further increase the risk and the limitations of raising funds[2].

Their ongoing liquidity problems can be traced back to a number of factors. Due to their weak bargaining position, they face long payment deadlines, while their suppliers are less likely to provide them with trade credit. The risk of non-payment by customers affects them much more. They have few customer and supplier relationships, so the loss of even just one customer or supplier can cause serious difficulties for them. They have little equity capital and typically engage in less asset-intensive activities, which does not favor the acquisition of debt resources. The specific transaction costs of obtaining funds are also much more significant for them than for large companies. Another limitation of external fundraising is the lack of transparency, that is, that their activities cannot be seen. The owner, who also plays the role of manager, tries to show the lowest possible pre-tax profit for the purpose of tax optimization. Therefore, financiers treat small business annual reports with caution. The biggest problem that arises when financing SMEs is the lack of collateral[3]. The aim of the financiers is to minimize their risk, and to this end they require companies to have as much coverage as possible. Most owners can only meet the collateral requirements of credit institutions by involving their private assets.

The capital requirements of start-up or growing businesses are relatively the highest when their income-generating capacity is the lowest. In the initial or growth phase of the company's life cycle, the signif-

icant capital requirement is typically coupled with negative net cash flows, which qualifies these companies as rather risky clients for financiers. In this case, lenders are only willing to provide short-term loans at best, with high financing costs and the inclusion of the owner's assets as collateral. Although, keeping in mind the principle of maturity matching, it would be justified to involve permanent funds for the acquisition and expansion of durable assets.

Informal investors play a significant role in the financing of start-ups. The circle of informal investors is often referred to as 3F or FFF in the literature based on the English term "family, friends and fools". One of the other possible ways of obtaining initial equity capital can be the involvement of venture capital[4].

For banks, businesses become attractive clients when, thanks to their increasing income-generating capacity, their need for financing is less significant. In the stage of maturity, a bank loan is a realistic financing option and a typical form of financing. Moreover, in a developed capital market, a company can use the tool of bond issuance. In this stage, significant internal resources are also generated (profit and depreciation), so companies no longer necessarily choose external resources.

The purpose of working capital financing is to ensure continuous liquidity, which can be ensured by coordinating income and expenses. A company's immediate solvency can be characterized using a short-term, cash-flow-based financial plan, known as a liquidity plan. From the liquidity plan, we can determine in which period and to what extent there is a lack of funds or a surplus of funds during the course of business, and we can look for solutions to finance the deficit or tie up excess funds.

Bridging the lack of funds is usually the biggest headache, but excessive liquidity is not good either, as it can worsen profitability. By increasing efficiency, the ratio of tied up current assets can be reduced, while cash management reduces costs and improves profitability by determining the optimal level of cash.

To ensure temporary working capital needs, companies mainly use internal funds, commercial loans or finance them with short-term external funds (working capital loans, overdrafts)[5].

Due to the cyclicality characteristic of agriculture, and agriculture within it, the financing of working capital in this sector is even more challenging.

Since joining the European Union and mainly as a result of EU agricultural subsidies, agricultural enterprises have become important clients for commercial banks and more and more financing schemes have appeared specifically for this target group. The spectrum of funding opportunities is further broadened by state interest subsidy and guarantee programs.

12.2 The classification of the types of financing, characteristics of certain financing forms

One of the pivotal points of corporate operation is financing, decisions related to financing. In Europe, credit institutions traditionally provide the corporate sector with short- and long-term funds. In the United States of America, direct funding from the money and capital markets is much more a part of the normal course of business. The source of financing a company can be realized not only from outside, but also with internal sources. We distinguish three types of internal sources:

- profit after tax,
- depreciation (amortization),
- sale of assets.

Among the three forms, the role of the after-tax result is clear. The company operates profitably – we assume that this is not only an accounting result, but also reflected in the cash flow – and instead of paying dividends, it invests the profit back into its operations. The form of financing is unrestricted, it can be used for both current stock and investment financing, and the management of the company decides on the method of use.

The role of depreciation in financing is perhaps less obvious. Fixed assets with a higher value (typically buildings, vehicles, software) cannot be accounted for in one sum as an expense, they must be capitalized and their value must be continuously reduced over the years and accounted for as an expense. From a

financing point of view, the effect of this is significant: When pricing products and services, depreciation can be calculated, costs and revenues can be balanced, so the return on investments is continuous.

A third form of internal financing is the sale of assets. In production companies, the role of tools is emphasized, so their sale is justified when they are exchanged for a better or newer tool. If the purpose of selling assets is to satisfy the demand for working capital, then the operation of the company is not sustainable in the long term.

The role and weight of internal financing is not clear among economists. From the owner's point of view, the goal is to increase the company's value. Properly utilized internal resources – typically unpaid dividends – increase the value of the company, but the fact that the owner can take dividends from his business is also valuable. However, internal financing is not suitable for financing long-term investments, and we must renounce the tax-saving function of debt. The "healthy" capital structure is unique for every company, which is influenced by the scope of activities, positive net present value investment opportunities, as well as the market environment and economic prospects.

There is no uniform, publicly agreed ratio for the development of the appropriate financing structure. In all cases, a balance must be found between company growth and the size of the dividend payment, and the ratio of external sources must be chosen accordingly. Among the external forms of financing, we will review the following:

- bank loan/loan/lease,
- factoring,
- venture capital,
- bond issue,
- issuance of shares.

Of the external sources, the forms of bank financing clearly dominate, typically in the form of loans or credits. We talk about a loan when the requested amount has already been disbursed by the credit institution, i.e. the amount is on the company's account or, in the case of asset acquisition, the seller has received the amount. In case of taking out a loan, the company and the bank agree on a credit line that the company can draw on. For individual investments (e.g. construction), a loan is the most typical form of financing, while for an asset purchase (e.g. a machine line) a loan is the appropriate option. Financial leasing is legally no different from a loan agreement. Operating leasing, on the other hand, is similar to a rental agreement, in the framework of which the asset is not included in the lessee's accounting and the lessee returns the asset at the end of the term. At the end of the financial lease, the asset typically remains with the company. When we hear the word leasing, we primarily think of vehicles, but this form of financing can also be used for production machinery.

Loan financing is a good solution for long-term projects. Of course, it is also possible to finance liquidity problems with a loan (e.g. revolving loan), but in all cases the term of the loan and the purpose of the loan must be harmonized so that the financing methods do not determine the operation of the company, but that the financing needs are adapted to the operation of the company.

Another possible way to solve the temporary financing need is factoring. During factoring, we sell an existing customer account to the factor house, of course in exchange for handling costs and interest. During factoring, we can "bring" the payment deadline to an earlier date, so we get money sooner. Factoring is a popular form of financing these days, there are companies that include the cost of factoring in the pricing of their products and services, because they know in advance that their receivables will be sold. A common objection to factoring is that it assumes a lack of trust between the buyer and the seller. The so-called "silent factoring" provides a solution to this, where the company's partner does not know that his account has been sold[6].

The traditional meaning of venture capital financing and its implementation in our region differ significantly. In the classic sense, venture capital is private capital that finances start-ups and small companies with high growth potential. During the financing, the company receives capital, in return the venture capital company receives a share of ownership, this capital has no interest, but a so-called exit value is determined. The exit can take place through a buyback by the original owner or a stock market issue. On the other

hand, in Central and Eastern Europe, the state and European Union programs have a significant share of the venture capital market, and the financing of start-ups and small companies is less important, high growth potential is more important.

Financing through the issue of bonds and shares is not considered a traditional form of financing in the region. With both forms of financing, the company reaches the capital market directly, no financial intermediary is necessary, as in the case of bank financing. Bond issuance is similar to borrowing. The company issuing the bond indicates what purpose it needs capital to achieve (it happens that there is no specific purpose), how much capital it needs and how much interest it is willing to pay for it. The issued bonds can be purchased by financial institutions (banks, investment funds, insurance companies, etc.) and private sector players, typically private individuals through some financial service provider. A bond issue is attractive to the bond issuer if it can obtain funds at a lower interest rate than a bank loan. The bond is purchased by market participants if it offers a higher interest rate than other financial products with a similar risk profile. One of the disadvantages of bond issuance is that, due to the high costs, issuance is only economical in large volumes.

Unlike the issue of bonds, the funds obtained during the issue of shares do not have to be repaid, the capital raised in this way is part of the company's equity. Risk capital is also part of equity capital, but there is a planned exit[7]. Of course, the capital raised without the obligation to repay is not free, the "price" is the transfer of ownership, so the existing owner gives up a significant part of his ownership share and, with it, control. On the other hand, your company is evaluated on a daily basis and your ownership becomes liquid, you can sell it at any time. One of the disadvantages of being on the stock exchange is the high degree of transparency, which has deterred many potentially listed companies from going public. Similar to issuing bonds, listing on the stock market can also be a suitable form of financing in case of a large size, this type of financing is not an option for small and medium-sized companies.

Last but not least, the member loan is also a possible form of financing, which is halfway between internal and external financing. On the one hand, it is external financing, because we keep the liabilities open and the company is burdened with a repayment obligation (in the case of a capital increase, there is no repayment). On the other hand, the existing owners of the company finance the company (perhaps from dividends received from previous years). Technically, it belongs to external financing.

Digitization and FinTech also affect financing and shape trends[8]. Nowadays, crowdfunding is also becoming commonplace, the different forms of which are close to different traditional forms of financing (e.g. equity-based or lending-based). We can also mention microloans, which are currently primarily available to private individuals. Developments related to blockchain technology are also possible processes in the field of financing. FinTech companies that have grown almost out of nowhere (e.g. Revolut, Wise) are also developing very quickly. These processes make it difficult and encourage the actors of the credit institution system to develop themselves and prefer digital solutions.

12.3 Special issues in the financing of agricultural enterprises

Modern agriculture is capital-intensive, and most of it can only be covered by loans. A drop in prices due to an unexpected drop in demand can cause serious problems. Through the development of sales revenue and income, the risk of production may adversely affect the producer. It is typical of the sector all over the world that producers take out larger loans and encumber their existing assets with mortgages. The result of this is that, as a result of unfavorable economic conditions, not only the economy goes bankrupt, but also the producer (farmer) is placed in an existentially threatened position. The willingness of banks to extend loans is also significantly influenced by the level of uncertainty associated with the activity in question.

One of the characteristic features of agricultural production is the long time of the product production process. (10 months for winter wheat, 18 months for calves, 7-8 months for slaughter pigs). The economic effect of this is that switching to another production process is time-consuming. A further economic consequence is that the economic program must be drawn up and recorded significantly earlier before the start of the production process.

A third economic consequence is that the payback period of investments and current assets is significantly longer than in the majority of industries. These characteristics are *factors influencing the maturity of loans, the size of the interest rate, and taxation as necessary.*

Due to the relatively long duration of production processes, agriculture also adapts relatively slowly to market conditions. By simply changing the amount of work, it is not possible to speed up the production process and multiply the production processes as in industry. Due to the relative length of the agricultural production process, the long-term economic objective and business comes to the fore[9].

Due to seasonality and the production cycle, the disadvantage of the business – even with a multilateral production structure – is the additional cost resulting from the interruption of income continuity. As long as the production process lasts, the costs (materials, wages, etc.) must be financed. Obviously, if this is done with a loan, the interest is an additional cost. The coordination of sectors with different production cycles and the multilateral production structure mitigated the disadvantage arising from the specific nature of agricultural production (e.g. the continuous income of dairy farming covers the costs of wheat production or pig fattening until the payback).

The peculiarity of the cycle, however, has significant agrarian political consequences. Farmers are not always able to cover their expenses during the production period and their livelihood until sales from their cash reserves. One solution could be a down payment from the customer. However, there is a need for a credit system (green loan, mortgage loan, other short-term low-interest loans) that can resolve this issue. Another solution is the payment of subsidies.

12.3.1 The practice of conventional financing by banks in the agricultural sector

The financing of agricultural enterprises is becoming more and more attractive for commercial banks, as more and more financing schemes are appearing, which almost completely eliminate the risk of the outsourced financial institution. While in the past, only the results of the enterprises served as "collateral" in addition to overdrafts and liquidity loans, *now temporary funds are provided at the expense of cash flows that can be said to be fixed, such as area-based subsidies or goods placed in public warehouses.*

Enterprises are characterized by low capital availability, risk avoidance and refraining from external sources. The financial resources of SMEs are usually based on the owner's assets. This greatly restricts their growth opportunities and productivity. The subsidy policy of recent years has largely shifted the financing of businesses towards non-refundable subsidies from the cohesion funds of the European Union[10]. This significantly *distorted market decisions and investment structure.*

When analyzing external financing and indebtedness, it is particularly important to take into account the seasonality of the agricultural sector and the difference between the farming year and the calendar year. According to the opinion of many agricultural experts, *the current practice of credit institutions does not tolerate the above characteristics of agriculture. The end-of-year data of agricultural* enterprises usually do not reflect the typical values of the agricultural enterprise, they are often worse from a management point of view than the mid-year data, which are only very rarely taken into account by the current accounting and crediting practice, since they usually work with end-of-year data[11]. *The sowing-harvest and purchasing-selling cycle of plant cultivation can differ significantly during the year, as a result of which different opinions can be formed about the same agricultural enterprise at different times.*

2006-2015. the level of indebtedness of individual farms was low, equity accounted for 78.3% of all resources on average. Typically, smaller, mainly individual enterprises have a higher share of equity in relation to the total balance sheet, while the amount of debt stock of cooperative enterprises is more significant, in their case the share of equity is only 63.9%. One of the main reasons for the high equity ratio is that in the 1990s, the realized income of the majority of agricultural enterprises was lower than the interest paid, so in case of higher indebtedness, the losses suffered by the owners are increasing. On the other hand, in the low interest rate environment of the 2010s, this remaining capital structure stands in the way of developments and investments. Those who develop only organically from a given year's results will be at a competitive disadvantage at the domestic and international level, *since the increase in results resulting from increased efficiency these days can more easily be higher than the relatively low loan interest rates.*

A risk management tool that helps agricultural producers insure against extreme environmental and weather effects is essential for building effective long-term bank financing. This tool must be adapted to the characteristics of the agricultural economy[12].

On the other hand, the high ratio of short-term liabilities is disadvantageous in the case of the agricultural economy, due to the relatively higher interest rates, and the shorter term than the production cycle carries an interest rate environment and liquidity risk. Here, the basic tendency is revealed, according to which the credit institutions - basically due to the poverty of their long-term sources and the additional risks occurring in the longer term - were reluctant to grant long-term loans. Furthermore, despite the many preferential loan schemes, the banks still use the simplest solutions to manage risks, so they set high risk premiums and ask for unrealistic coverage from the players in the sector.

12.3.2 State involvement in the financing of agricultural enterprises (state-subsidized loan programs)

The purpose of preferential financing schemes is primarily to give agricultural sectors with below-average profitability (mainly animal husbandry and certain horticultural sectors) a chance for development and breakthrough with the help of loans whose low interest rates also ensure the return on investments in the case of agriculture and the food industry, on the other hand provide long-term working capital to the capital-deficient sector. In Hungary, the Ministry of Agriculture (FM) tries to ensure preferential financing of the sectors basically with preferential loan schemes operated by the MFB, as well as with other agricultural financing programs operating with budgetary interest and/or guarantor fee subsidies, which were supplemented by the Growth Loan Program launched in 2013[13].

Relying on this discounted toolkit, agricultural and food industry enterprises could benefit from the following loan programs:

1. MFB loan programs

The common element of the agricultural financing programs operated by MFB Zrt. is the sectoral orientation, on the basis of which it is ensured that the funds of the program can only be used by the targeted group of borrowers for the purpose defined in the conditions, and the preferential interest charged by MFB Zrt. it is based on the difference in the market interest rate of the HUF. The credit programs charge foreign currency interest on HUF loans, and if MFB Zrt. incurs losses, the central budget compensates the bank for these losses based on an exchange rate guarantee agreement. In cooperation with the Ministry of Agriculture, MFB Zrt. launched three loan programs in 2015 – MFB Agricultural Current Asset Loan Program 2020, MFB TESZ Current Asset Loan Program 2020, MFB Food Current Asset Loan Program 2020. With its working capital loan programs, MFB Zrt. basically targeted three segments of agriculture: agricultural production (especially increasing the competitiveness of animal husbandry), providing working capital loans to fruit and vegetable producer groups and producer organizations, and increasing the competitiveness of the food industry. The loan programs are considered to be one of the lowest-interest, state-supported agricultural working capital loan schemes available on the Hungarian market.

2. Discounted EXIM constructions

The goal of Magyar Export-Import Bank Zrt. (Eximbank) and Magyar Exporthitel Biztosító Zrt. (MEHIB) is to provide efficient financing and insurance schemes for Hungarian exporters. The bank and insurance company, which operates within an integrated framework, performs its tasks in a joint organization and appearance, under the name EXIM. EXIM strives to cover the entire vertical of export activities from procurement to production to sales process support. With its export pre-financing products, Eximbank provides financing directly to exporters for the period prior to export performance, and indirectly, through credit institutions, in the form of refinancing loans. Post-export financing means the period that sets the export performance in stone, creating an opportunity for the exporter to provide his customer with deferred payment terms, while receiving the consideration immediately after the performance. Short-term loans have a term of 6-24 months, medium/long-term loans have a term of 2-5 years.

EXIM's export promotion loans were primarily used by large and medium-sized enterprises. Within the export promotion loans of large enterprises, long-term working capital loans dominated, but the proportion of investment loans also increased. Among medium-sized enterprises, the share of long-term working capital loans was outstanding. Small businesses primarily took out short-term working capital loans, while micro-enterprises mainly used investment loans.

3. Széchenyi Card Overdraft

Free-to-use current account loan for companies working in the agricultural sector, with preferential conditions, state interest and guarantee fee subsidies.

Advantages:

- state interest and guarantee fee subsidy,
- even without real estate collateral,
- fast and simplified credit assessment,
- can be requested at more than 200 points in the country,
- can be used for cash withdrawals and purchases by bank transfer or bank card.

The Széchenyi Card Program, which has been available to agricultural enterprises since 2011, also serves to make the short-term financing of Hungarian agriculture more stable. The Agrár Széchenyi Kártya (ASZK) Overdraft provides social enterprises, cooperatives and individual farms/enterprises (primary producers, family farms) working in the agricultural and food industry with overdrafts on preferential terms, with state interest and guarantee fee subsidies. Within the framework of the program, the Ministry of Agriculture continues to provide an annual interest subsidy of 4 percentage points and an 80 percent guarantee fee subsidy. As a result, the actors of the agrarian sector can obtain funds more easily with cheaper loans.

4. Growth Loan Program

NHP Hajrá is a new sub-program of the Magyar Nemzeti Bank's Growth Loan Program, which aims to help micro-, small- and medium-sized enterprises obtain loans to finance their new investments and operations, and to help them overcome the economic difficulties caused by the coronavirus epidemic. Within the framework of a new state-supported loan program with a fixed, maximum interest rate of 2.5% until the end of the term, it is also possible to apply for an investment loan, finance working capital, pay wages, modernize or replace an existing loan.

5. State involvement in the financing of agricultural enterprises (state-subsidized loan programs) in Croatia

From September 2019 onwards OTP, Privredna and Zagrebačka Bank as intermediaries for the implementation of the RDP Investment Loans for rural development provide investment loans for rural development. The product is based on a shared risk model whereby the 5. State involvement institution provides the part for 50% of the loan at 0% interest rate and the commercial intermediary bank adds the remaining 50% of the loan at aninterest ratepreviously agreed between the loan applicant and the bank, which depends mostly on risk factors and collateral offered. The minimum loan amount is fixed at EUR 5000 and each credit could be disbursed within a period of 18 months after its approval. Grace periods are also foreseen, up to three years (fiveyears for investmentsin orchards/vineyards)for eligible costs as indicated in specific sub-measures of the RDP.Receiving of applications for funding started in September 2019 and it is yet early for providing data[14].

12.4 Specific risks in the agriculture and in the food industry and their management with financial instruments (insurances)

Among the agricultural risks, the weather-related risk is of particular importance, as the probability of extreme weather conditions increases every year as a result of climate change. A harmonized agricultural risk management system has not yet been developed in the European Union. Therefore, Common Agricul-

tural Policy I. and II. pillar and in accordance with the regulations governing state subsidies, individual member states use different risk management tools.

Yield fluctuations related to extreme weather are much larger in Hungary than in other Western European countries, which is why Hungary uses a wide range of risk management tools. In this chapter, among the agricultural risk management techniques, the possible methods of crop insurance and the intensity of state subsidies related to them are presented[15].

1. Subsidies related to crop insurance in the European Union

Support for agricultural risk management first appeared in the European Union's Common Agricultural Policy in 2007. In the beginning, harvest damage mitigation was available in the fruit and vegetable sectors and in the national wine programs. After that, Article 68 of Regulation 73/2009/EC extended the possibility of damage mitigation to all agricultural sectors from 2008, but only France, Hungary, the Netherlands, and Italy applied it. In addition to the development of the damage mitigation system, since 2012 in Hungary, support for insurance premiums has also become available to agricultural producers[16]. Hungary used this fee subsidy in the period 2012-2014 based on Article 68 of Regulation 73/2009/EC, and in 2015 it was financed by the central budget as a group exemption subsidy. From 2016, farmers can apply for rural development support based on the Rural Development Program[17].

The Common Agricultural Policy II. In addition to the support of the mutual risk management fund and premium support for agricultural insurance, the income stabilization tool appeared as a new element in its pillar. The analyzes for the period 2014-2020 show that Italy is the only member state that will use all three instruments, all of which account for more than half of the resources planned at the EU level (1,590.8 million euros). Stabilizing the income of Hungarian agricultural producers is crucial from the point of view of agricultural production. In addition to the insurance premium subsidy, Hungary will introduce the income stabilization tool in the future, with which the risk management system will be extended to livestock producers as well. The latter tool will provide support to livestock farmers who suffer a loss of income of over 30 percent[18].

In the 2014-2020 period, Hungary earmarked 95.3 million euros for agricultural risk management subsidies provided on the basis of rural development programs. Only Italy (1,590.8 million euros), France (600.7 million euros) and Romania (200 million euros) planned more than this amount, of which Romania is the only country that does not use the insurance premium subsidy tool[19].

2. Crop insurance schemes in Hungary

Agricultural insurance accounts for 2.85 percent (HUF 10,956 million) of non-life insurance premiums in Hungary, of which 87 percent is the insurance amount related to agricultural crops. Currently, in Hungary, producers can choose from 4 types of crop insurance schemes to manage the risks inherent in crop cultivation.

In the case of the so-called traditional crop insurance scheme, the insurance companies reimburse even in the event of a 10 percent drop in yield. In this case, the farmers' share of the risk is small, so no state support can be granted to them.

In accordance with the construction of subsidized insurances determined on the basis of the rural development program, each insurance company develops the scope of premium-subsidized insurance offers. An insurance scheme is eligible for support if the insured event is associated with a decrease in yield of more than 30 percent per plant crop at plant level. So, in this case, the farmers' risk-taking covers the 30 percent loss of yield, for which they are entitled to state support. Comparing subsidized and non-subsidized schemes, it can be concluded that the essential element of the subsidy lies in the fact that the risks assumed by the insurance companies are lower. Thus encouraging insurance companies to take risks. In addition, in exchange for state support, the farmer must undertake to waive the claim for damages up to the extent of a 30 percent loss of yield.

The state-supported insurance schemes can be classified into 3 groups ("A", "B", "C") based on different risk assumptions and crops. For the financing of Rural Development Program No. 17.1.1 ("Subsidy for agricultural insurance premiums"), Hungary has set a budget of HUF 23.7 billion until 2020. The support framework

covers all three premium-subsidized insurance plans ("A", "B", "C"), however, the support rate differs for each plan. In the framework of the Rural Development Program, the financial settlement of the fee subsidy is done afterwards[20]. Therefore, as a first step, insurance companies create insurance plans that comply with the regulations of the support program ("A", "B", "C"). After that, the producer selects the types of risk for which he wants to take out insurance, and then they determine the construction suitable for his sowing structure. After the conclusion of the contract, the producer can indicate the type of subsidized insurance scheme ("A", "B", "C") in the uniform area-based support application for each plot. Based on the submitted application, the Agricultural and Rural Development Support Department keeps records and checks the correctness of the data. The condition for eligibility for the subsidy is that the producer pays the insurance premium in full to the insurance company by September 30 of the given year. Both parties must inform the Department of Agricultural and Rural Development Support about the fact of equalization. The financial arrangement of the support takes place after the payment of the fee for the entire year. The value of the subsidy is a fixed proportion of the insurance premium, which varies by type. Its maximum rate is 65 percent, but due to the annual subsidy frame, the actual rate may differ from the planned one. A decrease in the intensity of "B" and "C" type insurances, the reason for which is the different degree of risk-taking associated with the scheme.

3. Plant insurance risk elements and fee calculation

Plant insurance plans can be distinguished based on the insured risk elements. It can be linked to ice damage, flood damage, frost damage, storm damage and sand damage for insurance events, both separately and combined. In Hungary, there is a particularly high probability of frostbite damage, which mainly occurs during the growing season of cultivated plants[21].

Insurance companies classify individual plants into different risk classes. Thus, for example, the lowest risk is green fodder, medium risk is winter wheat and high risk is vegetables and fruits. The insurance company assigns fixed rates to these risks (the higher the risk, the higher the rate).

When calculating the premium, the insurance companies use the data specified by the producer. The producer must indicate how much yield he expects and what unit price he wants to sell the product at maturity. The so-called insurance amount is formed as the product of this expected yield and the market price, i.e. the producer has this amount of insurance. This insurance amount is weighted by a rate (%) determined based on the risk classification of the plant. Thus, in the end, the insurance premium to be paid by the producer is formed as a product of the premium and the insurance amount. The rates are in line with the probability of occurrence of weather hazards in Hungary, as the insurance company charges the highest multiplier in the case of ice damage that poses the greatest risk. It is somewhat lower in the case of storm damage, and a negligible fee is associated with fire damage.

4. Types of subsidized crop insurance

Type "A" plant insurance provides joint coverage for all risks, which includes insurance events such as hail damage, drought damage, flood damage, frost damage, cloud damage, storm damage and fire damage. In these constructions, those arable crops that have a significant sowing area in Hungary (corn, wheat, autumn cabbage rape, barley, sunflower) can be insured. The other two types contain fewer elements of danger than this extensive coverage.

In the case of type "B" and "C" insurance schemes, only ice damage, storm damage, winter frost damage and fire damage are considered insured events. In the case of types "B" and "C", the range of insured events is the same, only the range of insurable plants differs. In addition to field crops, a significant part of plantations and vegetable crops can be covered with type "B" insurance. Type "C" is available for all plants that cannot be provided in "A" or "B" construction.

12.5 Alternative financing models in agriculture

We have seen and still see well-functioning units, communities, and societies, the transformation of these continuous changes can be easily explained by technological progress, but the immoderate pursuit of indi-

vidual interests is less so. Not only in agriculture, but in many other economic and management areas, we can find the emergence of the need for sharing and cooperation.

The development dynamics of the agricultural and food sector is even more unique due to its exposure and characteristics. The agricultural and food economy is the basis of our past, our present and our future, which without community and cooperation turns into meaningless land use, which only serves to increase the wealth of the capitalists (owners)[22]. The development of technology brought with it a significant reduction of the workforce within the sector and the organization of collaborations exclusively on a market basis. According to a Hungarian survey, three reasons for staying away from cooperation can be identified in the sector: "Fear of commitment, dependence"; "Excessive view of the organization on the individual economy" and "Previous bad experience".

At the same time, we feel that the lack of cooperation results in economic problems such as unbalanced income distribution, market dominance independent of expertise and competitive disadvantage.

Can we find a good solution to eliminate this? In fact, we are looking for a model that is able to forge an advantage from cooperation for all actors and, by prioritizing common interests, can bring about the maximization of individual benefits.

As a practical example, we have dozens of community-based organizations in Hungary. Today, community farming is a personal collaboration between producer and consumer, in which the risks, responsibilities and fruits of farming are jointly shared in a regulated manner in a long-term agreement.

In practice today, this means that the farmer undertakes to produce for the members of the community throughout the year, while the customers undertake to receive the crops in exchange for a flat fee. Designing and financing the system is a big challenge from the part of the participants. However, nothing proves its importance better than the fact that, from 2017, substantial amounts of support became available for the development of the systems.

Let's review the factors that form the basis of today's collaborations.

12.5.1 Community farming

The literature links the emergence and rapid development of the sharing economy to the 2008 global financial crisis[23] and named the following four factors that drive the development of the sharing economy (Figure 2):

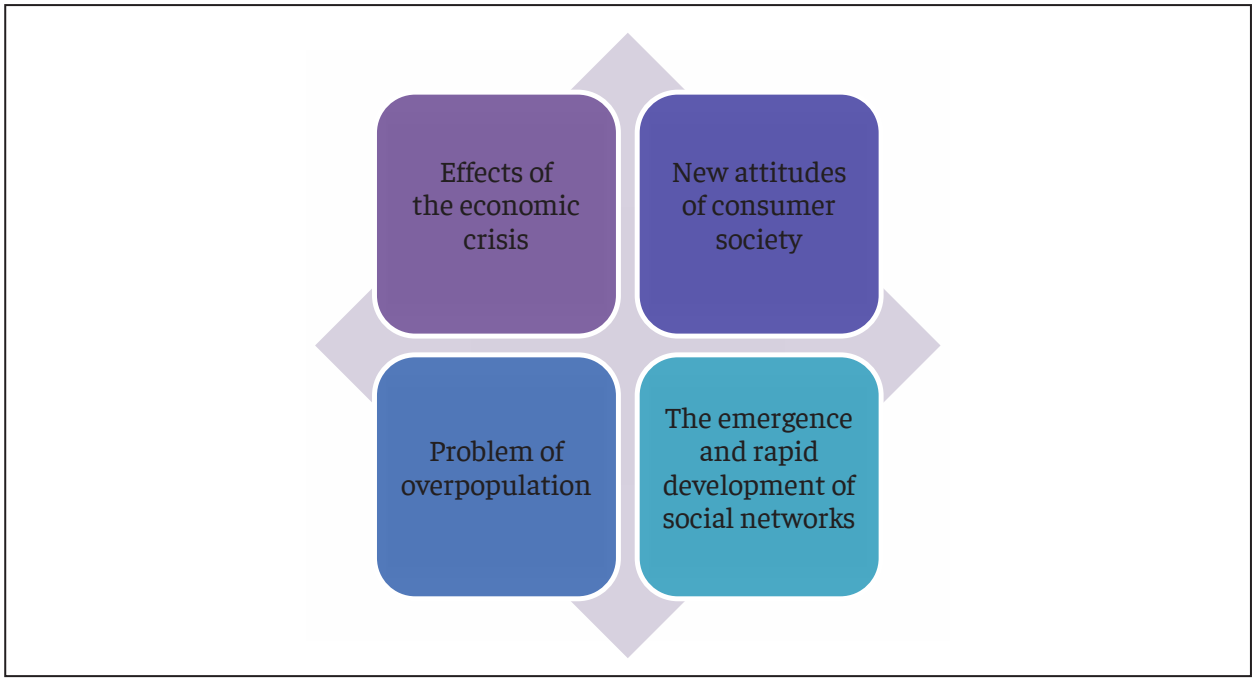

Figure 2. *Factors driving the creation and development of the sharing economy*
Source: Gansky (2010) following Kapovits (2016)

No one disputes the raison d'être of the factors, but it is difficult to identify their meaning. Maybe the XXI. The reason for the development and spread of the sharing economy can be found among the achievements and events of the 20th century, which can also be found in the definitions of the community economy.

The sharing economy is a business model that is based on the sharing of resources between individual players, and they access these through peer-to-peer services. The essence of the phenomenon can be understood in the fact that those tools and assets whose utilization is inadequate or not maximal become salable resources. It is based on C2C (customer to customer), i.e. a sales chain established between consumer and consumer, where the aforementioned goods and services are shared by consumers[24, 25].

In another formulation, the community economy can include four types of activities: reuse of products, better utilization of fixed assets, exchange of services and sharing of productive assets. In essence, it aims at the accessibility of unused resources, which includes information.

Based on the numerous definitions and good working examples, the characteristics of the community economy can be summarized as follows:

- Users share their resources.
- On-demand, i.e. the user can satisfy his consumption needs through the services – when they arise, he pays for the use depending on it.
- The users are members of a community, the degree of trust is high even without acquaintance.
- Sustainability – through cooperation and sharing, cost reduction can be achieved, which, by reducing the demand for new products, also results in the reduction of environmental pollution caused by production.

What makes the cloud organization created along the lines of community interests work? Digital platform providers match supply and demand for a fee. The service provider does not appear as an actor during the conclusion of the business, thus it is possible to conduct on-demand and P2P transactions. Among social services, the user pays for the use of the device and there are no maintenance costs. The basic services can typically be used for free or with a fixed monthly fee, in connection with which premium functions can be requested for a certain surcharge from the individual digital platform providers. The continuous transformation and development of the forms and spaces of communication naturally gives a changed interpretation to the community economy. Social networking sites, e-commerce, and chatbots all brought the development of new business models primarily in the last 10 years. P2P type transactions organized on the basis of community management can also be used very well to establish alternative retail channels in the food market[26].

How can agriculture and the sharing economy be connected? Agricultural collaborations and the sharing economy are not tied to a specific form, rather the technology for information exchange is necessary for (more) efficient use of unused resources. We can find many examples of this in the cooperation of local communities and the philosophy of operating local funds. When learning about domestic and international good practices, such as the Swiss WIR or the German Chimgauer, it is actually the exploitation of local resources and potentials that drives economic actors, resources and the local money system[27].

12.5.2 Cooperative models

Today, around 1 billion members are registered in the cooperative movement worldwide. According to ICA's estimate, cooperatives directly or indirectly play a role in the livelihood of nearly 3 billion people, and are of decisive importance in the economic and social life of local communities[28].

In the period following the regime change, cooperatives lost their credibility to a significant extent (in 2003, the number of cooperatives was over 2,000, but in 2017 only 574 agricultural cooperatives were active), so that a new word had to be found for the names of any cooperations that might be created, so that they are not create a sense of collective farm-model cooperatives in society or in the members participating in the cooperation[29].

From the point of view of cooperative theory, experts name three market failures. These are oligopsony, information asymmetry and limited bargaining power. In the case of oligopsony, the small number of buyers present on the market worsens the producer's bargaining position. If the producer is faced with asymmetric

information, he cannot enforce the quality differences of the products in the price. Limited bargaining power arises in the case of typically specific assets, investments, and the perishability of products. In this case, the producer is also forced to accept the price offered by the buyer. In reducing the risk caused by these factors, cooperative cooperation plays an important role and vertical integration represents outstanding efficiency, because in this case production, processing and commercial activity are also in one hand[30].

Knowing the particularities of the sector, therefore, in this type of cooperation:

- The frequency of transactions helps companies to realize transactions within the framework of internal coordination by establishing a management structure.
- The characteristics of production factors can encourage internal coordination between companies. The characteristics of the physical and intellectual production factors appearing in agriculture have a prominent role in the appearance of transaction costs and their extent. The tools related to carrying out agricultural activities (e.g. processing, soil cultivation, transport) can be very special, so there is only a specific demand for these tools, i.e. their market is special.
- Uncertainty, such as exposure to weather, is present to a large extent, which appears as a transaction cost.

During the past 30 years, the agricultural and food trade system of Central and Eastern European countries has undergone significant changes. The previous, mainly community- and state-owned structures were suddenly replaced by sales systems basically organized on a market basis. Compared to Western countries, this change took place much faster and more aggressively, which posed a significant challenge to domestic actors.

Privatization and the disintegration of the previously existing protection structures gave way to the rise of mainly foreign-owned retail and discount chains. This can be attributed to the fact that during this period there was a strong price competition among the market players, with which many companies could not keep up. This favored the expansion of large, capital-rich foreign multinational companies and greatly contributed to the development of the current sales structure. In the period that has passed since then, there have been several attempts to create purchasing networks and cooperatives bringing together farmers (e.g. HANGYA, TÉSZs, etc.) The attempts have often failed, since the retail system was no longer organically organized as a result of privatization can be attached to these structures. Without adequate sales channels, the farmers became vulnerable to the processors and large food chains, which in the meantime were mostly in foreign hands.

51% of Hungarian business units do not participate in any kind of cooperation, despite the fact that both the European Union and Hungarian decision-makers have become aware of the importance of the creation of cooperatives in improving the ability of producers to assert their interests. organized cooperation initiative, which could be a long-term solution to the problems of small producers[31].

12.5.3 Local money

It is difficult – perhaps impossible – to give an accurate estimate of the range of local currencies operating around the world. The vast majority of these are present in the most economically and financially developed regions, primarily in Europe and North America.

The biggest advantage of the introduction of local money can be seen as the boom in local trade and economy, and the rise in the economic performance of the given regions. Typically, local money is backed by a stable economy and a strong banking background, and its use consolidates local production and consumption, thus helping to keep local resources in the region.

Issuing local money means that we issue local money backed by collected money. Local money is an economic and not a legal term. The scope of community funds is a broader concept. The key to their operation is keeping the interests of the community in mind, in which money only plays an intermediary role. The economic actors see the satisfaction of local needs as their primary task, and their customer-supplier relationships are also predominantly outside the community. In fact, it means the creation of a settlement system in which local currencies only partially fulfill the function of national currencies[32].

The value measurement function, which is the expression of the value of a good or service, is fulfilled in all local monetary systems. Territorial limitations may arise, i.e. local funds can only be used in the specified community and at specified acceptance points. The traffic tool function, which is supposed to carry out the exchange, is also subject to territorial and voluntary limitations. No one can be obliged to accept local money, nor to pay debts solely in this, as one of the basic requirements of these systems is the voluntary nature. The payment instrument function - the temporary or permanent separation of goods and money circulation - is technically possible in all systems.

The limited nature of local money and its economic importance are mainly shown in the function of a means of accumulation. The essence of these systems is that they were not basically created to generate savings, but, on the contrary, to boost traffic at the local level[33].

Additional functions are also attributed to community funds, such as money circulation constraint, territorial interest protection, community wealth accumulation, etc.

Let's take a look at two European success stories from among the many functioning community money systems:

One of the best known is the WIR (Wirtschaftsring) system, which has been operating in Switzerland since 1934. WIR Bank, which was established in 1934 as WIR Cooperative and today manages the world's most successful complementary currency system in Switzerland. The WIR system was primarily aimed at stimulating trade between small and medium-sized enterprises. Its importance is confirmed by the more than 60,000 partner organizations that are active members of the system. Its importance is also shown by the fact that, in addition to the Swiss franc, their national currency also has its own currency code (CHW).

The essence of WIR is the "mutual settlement circle": in exchange for the products and services put on the market, the participants receive credit from the other members with which they can buy the products and services of other members. The participants who trade with each other form a kind of debtor community, where the members of the community stand in for each other's negative balance.

WIR Bank, as a third party keeping records, offers companies an additional currency in addition to the national currency. The WIR money substitute exists only in the form of currency and is issued when a WIR investment loan is granted, which can even be a structure consisting of a Swiss franc and WIR.

WIR loans in local currency only bear minimal interest, as WIR deposits are interest-free, so the bank does not incur any expenses. From the low loan interest, the bank can cover its administrative costs, the necessary reserve formation, and the dividend to be paid to members. Another consequence of the lower interest rate, in addition to lower burdens, is that it provides a higher turnover rate for the WIR compared to the Swiss franc. The "WIR franc", which is equivalent to the Swiss franc, is not suitable for paying taxes and public services, but it can be used for business expenses, capital investments, employee payments and personal expenses.

Chiemgauer was established primarily for non-profit purposes, primarily to support education and research. When operating Chiemgauer, environmental protection and research are priorities, not economic interest. Chiemgauer – in contrast to WIR – is a redeemable money substitute, so every Chiemgauer is backed by euros.

Accordingly, the coupon system was created and issued in the form of a non-profit organization. The aim of the initiative is to create an educational area that contributes greatly to the sustainable development of the region through special projects such as student companies, trainings, professional consultations, events and information. Through this, the concepts of environmental awareness, knowledge and economic benefit are intertwined for the people living in the region.

Bibliography

[1] Brealey, R. A., Myers, S. C., Allen, F., Mohanty, P. (2018). Principles of Corporate Finance, 12/e (Vol. 12). McGraw-Hill Education.

[2] Borszéki, É. (2001) Az agrárágazat finanszírozásának aktuális kérdései az EU csatlakozás tükrében. Előadás XLIII. Georgikon Napok Keszthely, 2001.

[3] Mura, L., Buleca, J. (2012) Evaluation of financing possibilities of small and medium industrial enterprises. Procedia Economics and Finance, 3, 217–222. https://doi.org/10.1016/S2212-5671(12)00143-8

[4] Durgula. J., Pataki, L. (2016) The startup ecosystem of Hungary in international context. In: Nowicka-Skowron, M., Illés, B. Cs., Tőzsér, J. (szerk.): Contemporary issues of enterprise management in Poland and Hungary. Szent István Egyetemi Kiadó, Gödöllő, pp. 193–204.
[5] Rajczi, A., Wickert, I. (2017) Examination of different sized agricultural enterprises operating profitability In: Szendrő K., Barna R. (szerk.) Abstracts of the 6th International Conference of Economic Sciences. Kaposvár University, Faculty of Economic Science, Kaposvár. p. 47.
[6] Klapper, L. (2006) The role of factoring for financing small and medium enterprises. Journal of banking & Finance, 30(11), 3111–3130. https://doi.org/10.1016/j.jbankfin.2006.05.001
[7] Klonowski, D. (2006ksh) Venture capital as a method of financing enterprise development in Central and Eastern Europe. International Journal of Emerging Markets, https://doi.org/10.1108/17468800610658325
[8] Kumar, K. (2018) Impact of Digitalization in Finance & Accounting. Journal of Accounting, Finance & Marketing Technology, 2(2), 1–9. http://management.nrjp.co.in/index.php/JAFMT/article/view/242
[9] Kerek, Z. (2004): A mezőgazdasági társaságok hitelezési és finanszírozási problémái, megoldásának lehetőségei. IX. Nemzetközi Agrárökonómiai Tudományos Napok. 2004. március 25–26. Gyöngyös. CD-kiadvány.
[10] OVIEW OF CAP REFORM 2014–2020 (2013) Agricultural Policy Perspectives Brief, http://ec.europa.eu/agriculture/sites/agriculture/files/policy-perspectives/policy-briefs/05_en.pdf
[11] Horváth, J. (2017) Agrárgazdaságtan És Vállalatgazdaságtan. SZTE MGK, Hódmezővásárhely.
[12] Bencze, Sz., Kiss, I. (2012) A kedvezményes hitelek szerepe a mezőgazdaság finanszírozásában, Hitelintézeti Szemle, 2012 (augusztus), 25–32.
[13] Balog, Á., Matolcsy, Gy., Nagy, M., Vonnák, B. (2014) Creditcrunch Magyarországon 2009–2013 között: egy hiteltelen korszak vége? Hitelintézeti Szemle, 13(4), 11–34.
[14] EIB 2020: European Investment Bank Financial needs in the agriculture and agri-food sectors in CroatiaJune 2020
[15] NAK (2016) Harmadával nőtt a támogatott agrárbiztosítások összege, https://www.nak.hu/agazati-hirek/mezogazdasag/146-noveny-termesztes/92887-harmadaval-nott-a-tamogatott-agrarbiztositasok-osszege
[16] VP3-17.1.1-16-Mezőgazdasági biztosítás díjához nyújtott támogatás pályázati kiírása, https://www.palyazat.gov.hu/vp3-1711-16-mezgazdasgi-biztosts-djhoz-nyjtott-tmogats
[17] Kemény, G., Varga, T., Fogarasi, J., Kovács, G., Tóth, O. (2010) A hazai mezőgazdasági biztosítási rendszer problémái és továbbfejlesztési lehetőségei. AKI, Budapest. (Agrárgazdasági Könyvek)
[18] Lentner, Cs. (2011) A pénzügyi stabilitásért. Magyar Hírlap online, 2011. 02. 25.
[19] Bardaji, I., Garrido, A. (2016) Research for Agri-Committee-State of play of risk management tools implemented by member states during the period 2014-2020: National and Eurpoean frameworks, Research Centre for Management of Agricultural and Environmental, http://www.europarl.europa.eu/RegData/etudes/STUD/2016/573415/IPOL_STU(2016)573415_EN.pdf
[20] Marselek, S. Takácsné György, K. (2011) A vidék fejlesztésének stratégiája. Gazdálkodás, 55(3), 251–257.
[21] Magyar Biztosítók Szövetsége (2017) Magyar Biztosítók Évkönyve 2016, http://www.mabisz.hu/images/stories/docs/publikaciok/evkonyv-2016-magyar.pdf
[22] Sarudi, Cs., Horváth, P., Bertalan, P. (2016) Magyar vidékfejlesztési programok és élelmiszertermelés. Élelmiszer, Táplálkozás és Marketing, 12(2), 23–28.
[23] Osztovits, Á.. Kőszegi, Á., Nagy, B., Damjanovics, B. (2015) Osztogatnak, vagy fosztogatnak? A sharing economy térnyerése, PricewaterhouseCoopers Magyarország Kft 2015, letöltve: 2018.04.14. https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/sharing_economy.pdf
[24] Eckhardt, Giana M., Bardhi, Fleura (2015) The Sharing Economy Isn't about Sharing at All, 2015. letöltve: 2018. 04. 20. https://hbr.org/2015/01/the-sharing-economy-isnt-about-sharing-at-all
[25] Parragh, B. (2016) Versenyképességi kihívások és lehetséges gazdaságpolitikai válaszok a sharing economy világában, Polgári Szemle, 12(4–6).
[26] Balyuk, T., Davydenko, S. (2019) Reintermediation in FinTech: Evidence from Online Lending. In: Cotter, J. (ed.) 31st Australasian Finance and Banking Conference 2018, Michael J. Brennan Irish Finance Working Paper Series Research Paper, pp. 18–17. https://dx.doi.org/10.2139/ssrn.3189236
[27] Varga, J. (2017): A Chiemgauer, mint sikeres helyi pénz működése. Közép-Európai Közlemények, 10(2), 91–100.
[28] Moizs, A. (2019) A szövetkezeti hitelintézetek Magyarországon. In: Kovács, T., Szóka, K., Varga, J. (szerk.) Pénzügyi Intézményrendszer Magyarországon: Soproni Egyetem Kiadó, Sopron. pp. 187–211.
[29] Takács, I. (2017) A mezőgazdasági együttműködések és a Sharing Economy, In: Szabó, G. G., Baranyai, Zs. (Szerk.): A szövetkezés-együttműködés akadályai, feltételei és fejlesztési lehetőségei a magyar élelmiszergazdaságban, Agroinform Kiadó, Budapest, pp. 291–320.
[30] Dudás, Gy., Fertő, I. (2008) A bizalom hatása a szövetkezeti tagok teljesítményére és elégedettségére a ZÖLD-TERMÉK termelői értékesítő szövetkezetnél. Gazdálkodás, 52(23. különszám) 49–55.
[31] Béza, D., Csákné Filep, J., Csapó, K. Csubák, T. K., Farkas, Sz., Szerb, L. (2007) Kisvállalkozások finanszírozása. Perfekt Kiadó, Budapest.
[32] Sárdi, G., Varga, J., Parádi-Dolgos, A. (2012) Helyi pénzek, helyi célok. I. Alternatív finanszírozási stratégiák Tudományos Konferencia, Sopron, 2012. okt. 3.
[33] Gál, V., Parádi-Dolgos, A. (2011) A helyi pénz és a pénzfunkciók kapcsolata? In: Lázár, E. (szerk.) Gazdasági és üzleti kihívások a Kárpát-medencében. Csíkszereda

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CHAPTER 13

Importance of relationship quality in food suppy chain management

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Fierce competition in today's global markets and increased consumer expectations have forced companies to invest and focus on relationships with their customers and suppliers. Contemporary managerial thinking advocates the cooperation of business partners and responds to customer needs as an additional incentive to a successful competitive strategy.

One of the critical factors in AFSC is how to ensure fair cooperation between stakeholders and at the same time pay attention to economic, environmental, social, organizational, marketing and safety factors and responsibility towards companies, consumers and society[1]. Managers in production and retail and managers of agri-food companies are becoming aware that successful coordination, integration and management of key business processes and quality cooperation of all stakeholders in the supply chain will ultimately determine their competitive success.

One of the goals of the supply chain is that companies do not view each other individually, but as members of a competitive network in which more companies are involved in creation of value. This goal can only be achieved through the cooperation of all participants in the supply chain, because the network has a competitive environment that brings benefits to all stakeholders and strengthens the supply chain. That is why it is important for the supply chain to integrate individual members and companies in the network in order to achieve the greatest possible benefits for members of the supply chain through cooperation[2].

All participants in the AFSC should make efforts to improve the functioning of the chain, especially in terms of quality, competitiveness, pricing, requirements for absolute safety of agri-food products and the interrelationships between members of the chain (trust, communication, knowledge exchange, loyalty, etc.).

13.1 Integration and collaboration in Agri-food Supply Chain

In economics, the term integration means the merging of individual business partners and processes into an organized system for better joint market performance that will reduce costs, increase competitiveness and success of each business partner. Collaboration is a process in which several people or businesses come together (integrate) to do a job or activity, sharing tasks and roles, helping each other and coordinating

efforts to achieve a common goal. This implies cooperation that includes partnership, joint leadership, risk sharing, co-decision, ie a closer and more intensive relationship, equality and commitment. Here are some definitions of cooperation in supply chains:

Mentzer et al.[3] "Supply chain cooperation" means "a business process in which collaborating partners work together to achieve common goals that are mutually beneficial to partner companies".

Humphries and Wilding[4] argue that cooperation means "working together to bring resources together to achieve effective operations in line with the strategies and goals of the parties involved, resulting in mutual benefits"

According to Simatupang and Sridharan[5], supply chain cooperation is defined as "two or more chain members working together to create a competitive advantage by exchanging information, making joint decisions and sharing benefits derived from greater cost-effectiveness and end-customer needs. himself".

Within the AFSC, there may be different levels of cooperation (vertical cooperation, horizontal cooperation, internal cooperation, external cooperation, which in turn can be downstream or upstream, etc.). The quality of cooperation will depend on many factors: product characteristics, business relationships and business processes, number of chain stakeholders, supply chain complexity, supply chain position, information exchange among chain stakeholders, mutual trust, etc.

In supply chain management, it is important to achieve the appropriate level of integration and cooperation between the partners in the chain, since the success of each individual entity in the supply chain does not depend solely on itself, but on their joint market presence. In order for a business to be successful, each member must gain an appropriate level of trust in other members and accept the fact that he is dependent on the business of other members in the supply chain.

According to Dani[6], cooperation can be considered in three forms:

1. transactional cooperation: this includes simple communication and data exchange between partners;
2. cooperative cooperation: this includes partners who share data and processes and set common supply chain objectives; and
3. cognitive cooperation: this requires a higher level of involvement, as partners work together in joint planning and decision-making and develop a relationship of mutual trust and interdependence.

In order to achieve the objectives of the AFSC, it is important that all members of the supply chain are integrated and work together because the supply chain is "strong" only as the weakest link in it. For example, if a member of the supply chain does not comply with legal regulations and standards, it affects all partners because there is a decline in the reputation of customers and the public[7].

13.1.1 Vertical and horizontal collaboration

When we talk about integration or cooperation in agri-food supply chains, cooperation can be horizontal and vertical. The type of cooperation will also significantly affect the supply chain management[8, 9].

1. *Horizontal cooperation* – this type of integration is characterized by the cooperation of organizations at the same channel level, usually under the leadership of one of the participants. This means integrating several companies that produce the same types of products or the same level of production processes along the supply chain (eg different farmers integrate into a cooperative). It can also be a question of uniting mutual competitors. Frequent examples are joint distribution in individual markets where individual companies do not have enough resources to develop a quality distribution channel on their own. Two or more companies at the same level join forces to create new market opportunities. Companies combine their capital, sales teams and expertise, production potentials, marketing resources and thus achieve more than they would achieve individually. In this way, producers, retailers or any other participants from the same economic level can come together.
2. *Vertical cooperation* – consists of connecting different stakeholders (eg agricultural producers, processors, retailers) who act as a single system, but the participants are not at the same economic level. Individual participants from different economic levels come together to improve their own business and stand out from the competition. Vertical supply or value chain integration requires farmers, food

processors and food retailers to develop and maintain close and sustainable business relationships with each other. Full vertical channel integration will mean that one member has mastered all parts of the channel from producer to consumer. A higher degree of vertical coordination introduces more complex relationships among chain stakeholders and increases the level of interdependence among them. However, at the same time, vertical cooperation leads to greater coordination between, for example, farmers and food processors, which results in improved economic performance. The quality of agri-food products must be maintained at all stages of the supply chain from receiving production to the final consumer. As a result, agri-food supply chains are more intensively vertically coordinated than other supply chains. This is especially true of organic production chains. Based on research conducted in the German agri-food chain in two different phases (farmer-processor and processor-trader) and two different types of relationships (formal and informal), Reynolds et al[10] conclude that effective communication, personal connections and equal the distribution of power between customers and suppliers is a key determinant of sustainable vertical business relationships. The relevance and meaning of the determinants differ at different stages of the supply chain and in formal and informal types of relationships.

It should also be noted that contracts between farmers and processors are an instrument that supports a strong production link between the two phases of the chain, allowing for a greater degree of vertical coordination. The integration of the agricultural sector and processing should be strong, because the processor must be sure of the origin of raw materials and the fact that agricultural production is in line with the set standard of the production process. The supply chain of fresh produce is mainly linked by contract, and in the relationship between primary farmers and processors, contracts are more frequent[11]. Supply contracts allow for a greater degree of vertical coordination, including greater interaction between chain stakeholders, because the set of rules is fixed (delivery schedules, pricing and product characteristics), thus improving traceability, quality assurance and security of supply to end consumers. In addition, processing companies purchase raw materials mainly from national, regional and local markets, facilitating vertically coordinated production. Contract agriculture can also bring significant benefits to farmers. With a reasonable contract, the farmer gains customer confidence, a fixed price (reducing the risk of price volatility), contracted loan terms and reduced marketing costs. In the medium to long term, 'contractual relations' and vertical coordination can lead to better relations and positions of interdependence. However, small farmers who do not have enough production volume to sell directly to the buyer find it difficult to find their place in such a partnership.

Vertical cooperation between food chain stakeholders is influenced by several factors: complex interaction between stakeholder strategies (eg processors and traders), power asymmetry between upstream and downstream companies, supply chain constraints (eg farmer-trader) and types of chain management structure supply[12].

Since cooperation is based on relationships, whether at the interpersonal or organizational level in the context of supply chain management, there are also intraorganizational or internal cooperation, which refers to cooperation within organizations and interorganizational or external cooperation, which refers to the cooperation of all members in the supply chain[13]. Vertical collaboration includes collaboration with customers and suppliers and collaboration within the organization. Horizontal cooperation includes cooperation within the organization and its entities, but also external cooperation with competitors and other organizations. Internal collaboration refers to the organization's culture of collaboration (for example, the existence of elements of trust and commitment). External downstream cooperation includes customer relationship management, while external upstream cooperation includes supplier management. There may be different levels of relationships within a supply chain.

Cooperation in the context of inter-organizational relations is very important, because when it comes to developing the quality of relations between companies or supply chain stakeholders, it is crucial to achieve the prerequisites for successful cooperation, including trust, because without trust between business partners, partnerships can not be successful.

13.1.2 Prerequisites for collaboration and relationship quality

Due to different product characteristics (fresh, processed food) there are different AFSC relationship structures (eg farmer-processor; farmer-trader, processor-trader, etc.) or forms of governance that significantly affect the quality of cooperation and relationships. In the case of AFC, both business relationships (e.g., price, cost, and market) and social relationships (e.g., local connections, trust, and friendship) are considered vital to its success[14]1.

Close cooperation can help reduce business uncertainty and risk and achieve better performance for each stakeholder and the entire supply chain. In order to achieve this, it is necessary to achieve certain prerequisites for quality cooperation.

Wilding & Humphries[15] list ten attributes that foster supply chain collaboration: reliability, long-term focus, communication, stability, win-win, trust, willingness to compensate, personal relationship, creativity, and C3 (collaboration, cooperation, and coordination). Bezuidenhout et al.[16] believe that a lack of attributes such as reliability, trust, good personal relationships and communication cause fragmentation, opportunism and a desire for excessive control of individuals in the chain, and that reciprocity and communication are key strengths of the system. In his research, Aji[17] singles out four key variables for building relationships: satisfaction, trust and two dimensions of commitment – commitment to continuity and commitment to support. Schulze & Spiller[18], in researching the quality of relationships in the German pork sector, also argue that relationship quality must be conceived as a construct that encompasses satisfaction, trust, and commitment.

In business cooperation, the failure of either party seriously affects the performance of the other party. The human element within the supply chain partnership is extremely important for the partnership to function, so changes in organizational culture and behavior are necessary in creating a quality of cooperation in the supply chain. Cooperation is vital to empowering small farmers, especially those in communities with low socio-economic status. As key stakeholders in the AFSC, farmers typically have limitations in business skills, aspirations, and systematic thinking, so they often focus heavily on their business rather than creating an integrated collaborative system. Conflicts and misunderstandings can be minimized by understanding and managing the factors, ie the preconditions of quality cooperation in partnership in AFSC. Accordingly, several key prerequisites for quality cooperation in the AFSC shown in Figure 1 will be explained in more detail.

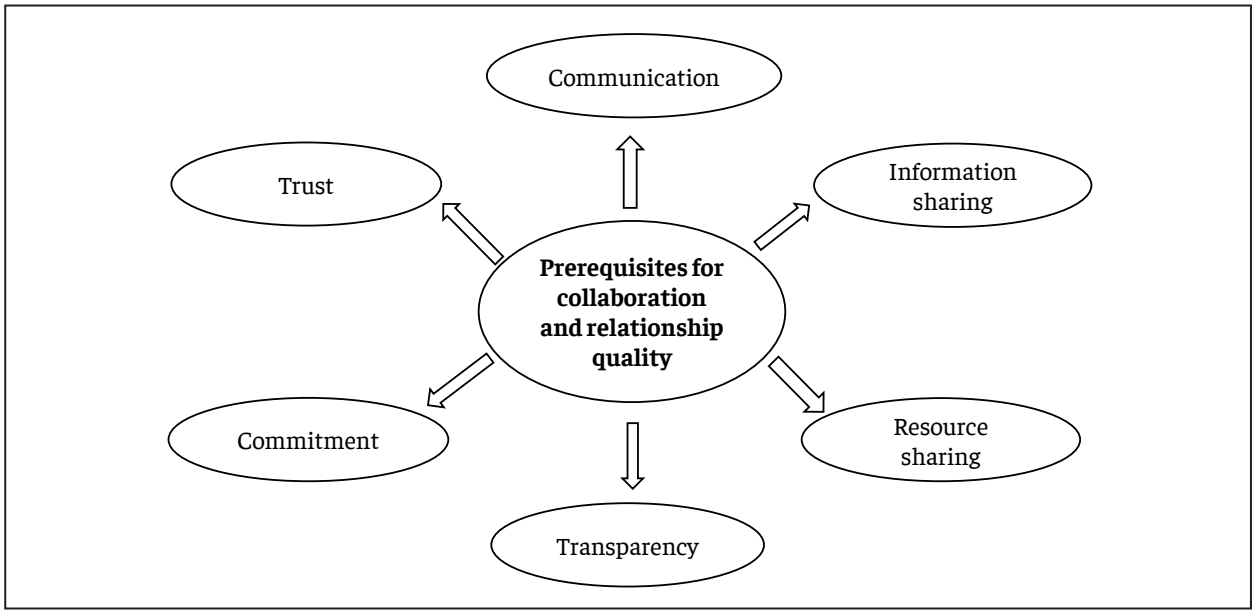

Figure 1. *Key prerequisites for quality cooperation in AFSC*
Source: Author's work

[1] Paper in the publishing process

1. Trust

Trust is a central component of AFSC management and only in this way can the food supply chain be successful. Trust is an important strategic condition and one of the main factors that can improve or limit (in case of mistrust) successful cooperation in the AFSC. In the agricultural sector, trust is more important for small and medium enterprises, which are characterized by the existence of personal relationships between business partners[19, 20].

There is no single definition of trust and different authors distinguish different forms of trust in business relationships. Eg:

Trust is considered to exist if "one party believes that the other is fair or well-intentioned"[21].

Trust can be seen as the opposite of opportunism in business relationships. Therefore, trust is defined as the belief that a business partner can rely on the fulfillment of its obligations in a situation involving risks and vulnerabilities[22].

In operational terms, 'trust' refers to the belief that the other party is honest and fair and under no circumstances will it intentionally do anything that would damage the relationship. Quality cooperation, trust and commitment are important prerequisites for food quality as one of the important indicators of the success of the agri-food supply chain[23].

Laeequddin et al.[24] noted that there are three key perspectives on trust in supply chain relationships:

1. *Characteristic trust* – deals with factors such as perception, reliability, credibility, commitment, honesty, goodwill, honesty, good will and emotions, etc.
2. *Rational trust* – deals with factors such as relationship economics, dynamic partner capabilities and technology adoption.
3. *Institutional trust* – deals with factors such as control mechanisms between supply chain members through legal frameworks, commercial law, contracts, agreements, bank guarantees and insurance.

In order for trust among business partners to develop successfully, certain preconditions of trust must be met. Different literature shows different prerequisites of trust within the AFSC. Thus Batt[25] identifies perceived honesty, credibility of information, reliability of promises, relationship satisfaction, compatibility of goals, and relationship investment as factors that build trust in the fresh food chain. Puspitawati et al.[26]. list eight predecessors of trust in AFSC: communication, price transparency, price satisfaction, price quality ratio, joint problem solving, partner reputation, dependence and flexibility in the relationship. Numerous authors agree that the most important determinants of trust in AFSC are the quality of communication achieved by the frequency of communication and the quality of information, together with a positive experience of cooperation[18, 27, 28]. Trust can be based on "contractual trust" contracts, on the capabilities and knowledge of the business partner "trust of competences" and on the willingness and commitment of the other party "trust of good will"[29].

The higher the level of trust between the partners, the more likely it is to develop long-term cooperation. After developing a high level of trust, quality cooperation, good communication and strong personal relationships between the partners, the parties begin to engage in activities such as joint product development, co-investment or the development of innovation capacity[30].

2. Communication

Another important category of cooperation and one of the prerequisites for trust is communication between business partners. Effective and efficient communication is a prerequisite for quality cooperation[31]. Through continuous and honest communication, supply chain problems can be avoided and solutions can be found more easily, which greatly simplifies and improves cooperation among supply chain members[32].

3. Information sharing

The exchange of information is a key feature in the category of cooperation, as the exchange of information not only reduces uncertainty among business partners, but leads to better efficiency, flexibility and faster response of the entire supply chain[2]. This includes, in particular, sensitive strategic and tactical information about the company, such as demand forecasts and sales strategies, which the focal company shares

with its supplier[33]. Lack of information within supply chain partners leads to increasing fluctuations in demand upstream in the supply chain[34]. As a result of frequent information exchange, processes within the supply chain can become more efficient, savings can be achieved and costs can be reduced, thus avoiding the bullwhip effect, ie extreme changes in the amount of stock from the end to the beginning of the supply chain. which is caused by a small change in supply chain demand.

4. Sharing of resources

Resource sharing is also one of the subcategories of collaboration and differs from information sharing in its physical nature. While the latter refers to the sharing of data and information, the sharing of resources between supply chain partners involves the sharing of physical, financial, human and organizational resources[35]. Through collaboration, companies can pool their resources and create a sustainable competitive advantage. However, companies not only share information and resources with each other, but also share risks if they work together successfully. As a result, supply chain members alleviate uncertainty.

5. Transparency

Transparency between supply chain partners improves communication within the supply chain and increases the exchange of information, which can lead to successful cooperation and improve overall supply[26]. Transparency is particularly important in the case of pricing, as customers have high demands that their suppliers can communicate price changes as quickly, comprehensively and up-to-date as possible, in order to reduce uncertainty and achieve better planning security[36]. This strengthens the bond between the partners and can lead to trust. If there is close cooperation between supply chain partners, mutual support can be expected in improving and further developing inter-company relations, as well as further product development[37].

6. Commitment

Commitment or commitment reflects the organization's faith and commitment in maintaining and improving relationships with partners to work together to create value in the long run. Like trust, it is one of the most critical behavioral factors for successful cooperation in the agri-food supply chain[38]. Trust and commitment lead to the creation of loyalty in relation to a business partner.

In addition to the previously mentioned and described factors that enhance cooperation between partners in the supply chain, there are also those that can negatively affect the development of cooperation, such as excessive use of power and opportunism.

1. Power

The power factor speaks about the ability of a person or organization to influence the behavior, decisions and actions of others by shaping parameters in cooperation and leading the direction of partnership[39]. Power can also be used to determine pricing, inventory, operations, supply chain structure, and distribution of information in the supply chain. The more powerful the organization, the more it will be able to influence the types of information shared, the recipients, and the sharing mechanism in collaborative activities. However, the power function should not be used to exploit weaknesses, but to support and help find better ways to solve partnership problems, increasing mutual benefits and competitive strategies[38].

2. Opportunism

Opportunism is a risky situation in which companies and individuals seek to take advantage of the situation. In inter-organizational relations, opportunism occurs when one or more parties exploit the vulnerabilities of other parties in search of their own unilateral gain at the substantial expense of other parties and/or the relationship as a whole[40]. It is a search for self-interest, which lacks honesty. Hobbs[41] states that the risk of opportunism increases in certain situations in supply chains, where the bargaining power of the chains is not evenly distributed. For example, when there are only a few buyers of products from many suppliers, as in most agricultural products in rural areas, the bargaining power of producers may be limited. Therefore, there

is a high risk that customers will act opportunistically. Some examples of opportunistic customer behavior (e.g. trader) are: the trader controls all information and does not share it with producers, the trader does not treat his supplier fairly and honestly, ie as an equal partner in the supply chain, the trader does not care about the supplier's welfare their interests and well-being, etc. The lower the opportunism of the supply chain partners, the greater the trust in the entire supply chain network.

13.2 Agri-Food Supply Chain performance measurement

Cooperation and trust can help improve the efficiency of the agri-food supply chain. Supply chain performance refers to the overall performance of a chain that depends on the performance registered at each stage of the supply chain[42]. Therefore, it is important to improve not only the performance of individual members in the supply chain, but all participants in the supply chain. Competitive advantages are among the main strategic goals of the supply chain and can be generated and consolidated not only through the exchange of resources and information, but also through other indicators such as cost, delivery and delivery speed, quality and flexibility[31]. Performance measurement is the process of qualifying the efficiency and effectiveness of the supply chain. In practice, there are a large number of performance indicators that mainly depend on the specific characteristics of the supply chain, which is why there is no single definition of performance indicators. Some of the definitions are:

"Performance measures serve as an indicator of how well a business initiative, process or system is functioning"[43].

Performance indicators are the criteria by which the performance of products, services and production processes can be assessed[44].

The success of a company is the result of a cooperative relationship in the supply chain in the form of increased sales, productivity and market share[45].

Due to the specifics of agri-food chains and the characteristics that distinguish them from other supply chains, performance measurement is not easy to perform[46]. Performance indicators of agri-food supply chains are grouped into four main categories[42, 46, 47]: efficiency, flexibility, responsiveness and food quality. Each of these main categories contains more detailed performance indicators.

1. Efficiency measures the optimal use of resources in the supply chain. It has the aim to maximize the added value of the process and minimize costs. Some of the indicators for measuring performance are:

- *Production costs and distribution costs* – combined costs of raw materials and labor in the production of goods, combined distribution costs, including transport and handling costs.
- *Inventory costs* – are manifested through the time of inventory turnover.
- *Transaction costs* – costs incurred in trade in goods or services (eg search costs, negotiation costs and implementation costs).
- *Waste costs* – incurred in production, distribution, inventory management, etc.
- *Profit (profit)* – a positive return on investment or business after deducting all costs.
- *Return on investment* – a measure of a company's profitability and a measure of how efficiently a company uses its capital to make a profit.
- *Asset value (inventory)* – company goods, raw materials, finished and unfinished products not yet sold.

Through process improvements, faster inventory turnovers, or lower transaction costs, cost reduction can occur, improving supply chain performance.

2. Flexibility – the ability to adapt to a changing environment (eg. responding to changes in the market in order to gain or maintain a competitive advantage or to changes in customer demand). Some of the indicators for measuring flexibility are:

- *Customer satisfaction* – the degree to which customers are satisfied with products or services.
- *Volume flexibility* – the ability to change the output levels of manufactured products.

- *Delivery flexibility* – the ability to change planned delivery dates.
- *Reserve orders* – an order that is not currently in stock, but is being ordered and will be available later.
- *Lost sales* – an order lost due to inventory because the customer does not want to approve/accept the backlog order.

3. Responsiveness – the speed at which the supply chain delivers products to the customer.
Some of the indicators for measuring responsiveness are:

- *Charging speed* – the percentage of units ordered that are delivered by order.
- *Product delay* – the time between the promised product delivery date and the actual product delivery date.
- *Customer response time* – the time between the order and the corresponding delivery.
- *Runtime* – the total time required to produce a particular item or service.
- *Customer complaints and returns* – Registered customer complaints about a product or service and product returns.
- *Delivery errors* – incorrect product deliveries.

4. Food quality and food safety – special characteristics of chains food supply that implies product and process quality. Some of the indicators for measuring food quality and safety are:

- *Sensory properties, appearance and shelf life* – a first look at the food, a combination of different attributes, such as color, size and shape, strength, lack of stains and damage.
- *Taste* – determined by the sweetness, bitterness and aroma of vegetables/fruits.
- *Shelf life* – how long the packaged food will last without change or deterioration.
- *Health and nutritional values of the product* – that the product is healthy and qualitatively nutritious.
- *Product safety* – the product does not exceed an acceptable level of risk associated with pathogenic organisms or chemical and physical hazards such as microbiological, chemical and physical contaminants in the products.
- *Process quality* – consists of the characteristics of the production system that indicate the method of food production and includes factors such as pesticides used, animal welfare and the use of genetic engineering and environmental aspects such as the use of packaging and food waste management.

Supply chain performance indicators depend on the quality of cooperation of members in the supply chain and their mutual trust. Achieving a high level of efficient and successful relationships and cooperation also ensures the sustainability of agri-food supply chains.

Bibliography

[1] Fritz, M., Schiefer, G. (2008) Food chain management for sustainable food system development: a European research agenda, Agribusiness, 24 (4), 440–452. https://doi.org/10.1002/agr.20172
[2] Kache, F., Seuring, S. (2014) Linking collaboration and integration to risk and performance in supply chains via a review of literature reviews, Supply Chain Management: An International Journal, 19 (5/6), 664–682. https://doi.org/10.1108/SCM-12-2013-0478
[3] Mentzer, J. T., Stank, T. P., Esper, T. L., (2008) Supply chain management and its relationship to logistics, marketing, production, and operations management. J. Bus. Logist. 29, 31–46. https://doi.org/10.1002/j.2158-1592.2008.tb00067.x
[4] Humphries, A., Wilding, R. (2004) Long term collaborative business relationships: the impact of trust and C3 behaviour, British Journal of Marketing Management, 20(9–10), 1107–22. https://doi.org/10.1362/0267257042405240
[5] Simatupang, T. M., Sridharan, R.. (2005) The collaboration index: a measure for supply chain collaboration. Int. J. Phys. Distrib. Logist. Manag. 35, 44–62. https://doi.org/10.1108/09600030510577421
[6] Dani, S. (2015) Food Supply Chain Management and Logistic From farm to fork, London, Philadelphia & New Delhi: Kogan Page, ISBN 978 0 74947364 8
[7] Zhang, L., Xu, Y., Oosterveer, P., Mol, A. P. (2016) Consumer trust in different food provisioning schemes: evidence from Beijing, China, Journal of Cleaner Production, 269–279. https://doi.org/10.1016/j.jclepro.2015.09.078
[8] Dania, W. A. P., Xing, K., Amer, Y. (2016) Collaboration and sustainable agri-food supply chain: a literature review, in. Jamari, J., Handogo, R., Suryani, E. (Ed.s) MATEC Web of Conferences, Vol. 58, The 3rd Bali International Seminar on Science & Technology (BISSTECH 2015), Bali, Indonesia, 02004, https://doi.org/10.1051/matecconf/2016802004

[9] Cavaliere, A., Peri, M., Banterle, A. (2016) Vertical Coordination in Organic Food Chains: A Survey Based Analysis in France, Italy and Spain, Sustainability, 8(6), 569. https://doi.org/10.3390/su8060569
[10] Reynolds, N., Fischer, C., Hartmann, M. (2009) Determinants of sustainable business relationships in selected German agri-food chains, British Food Journal, 111(8), 776–793. https://doi.org/10.1108/00070700910980919
[11] Sufiyan M., Haleem A., Khan S., Khan M. I. (2019) Analysing Attributes of Food Supply Chain Management: A Comparative Study, Shanker K., Shankar R., Sindhwani R. (Ed.s) Advances in Industrial and Production Engineering, Springer, pp. 515–523. https://doi.org/10.1007/978-981-13-6412-9_50
[12] Hingley, M. K., Sodano, V., Lindgreen, A. (2008) Differentiation strategies in vertical channels: a case study from the market for fresh produce, British Food Journal, 110(1), 42–61. https://doi.org/10.1108/00070700810844786
[13] Burgess, K., Singh, P. J., Koroglu, R. (2006) Supply chain management: a structured literature review and implications for future research, International Journal of Operations & Production Management, 26(7), 703–729. https://doi.org/10.1108/01443570610672202
[14] Gajdić, D., Mesić, Ž., Petljak, K. (2021) Preliminary Research about Producers' Perceptions of Relationship Quality with Retailers in the Supply Chain of Organic Food Products in Croatia // Sustainability, 13 (2021), 24; 1-41. https://doi.org/10.3390/su132413673
[15] Wilding, R., Humphries, A. S. (2006) Understanding collaborative supply chain relationships through the application of the Williamson organisational failure framework, International Journal of Physical Distribution & Logistics Management, 36(4), 309–329. https://doi.org/10.1108/09600030610672064
[16] Bezuidenhout, N. C., Bodhanya, S., Brenchley, L. (2012) An analysis of collaboration in a sugarcane production and processing supply chain, British Food Journal, 114(6), 880–895. https://doi.org/10.1108/00070701211234390
[17] Aji, J. M. M. (2016) Exploring Farmer-Supplier Relationships in the East Java Seed Potato Market, Agriculture and Agricultural Science Procedia, 9, 83–94. https://doi.org/10.1016/j.aaspro.2016.02.130
[18] Schulze, B., Spiller, A. (2006) Determinants of Trust between Buyers and Suppliers in Agribusiness: Empirical Evidence from the German Pork Sector, Paper prepared for presentation at the 99th EAAE Seminar 'Trust and Risk in Business Networks', January 8-10, Bonn, Germany, available at: https://ideas.repec.org/p/ags/eaae99/7719.html
[19] Fischer, C., Gonzalez, M. A., Henchion, M. M., Leat, P. M. (2006) Factors influencing trust-supporting mechanisms in European agri-food chains, Paper prepared for presentation at the 99th EAAE Seminar „Trust and Risk in Business Networks", Bonn, Germany, February 8–10.
[20] Lu, H., Feng, S., Trienekens, J. H., Omta, S. W. F. (2012) Network strength, transaction-specific investments, inter-personal trust, and relationship satisfaction in Chinese agri-food SMEs, China Agricultural Economic Review, 4(3), 363–378. https://doi.org/10.1108/17561371211263374
[21] Doney, P. M., Cannon, J. P. (1997) An Examination of the Nature of Trust in Buyer-Seller Relationships, Journal of Marketing, 61(2), 35–51. http://www.jstor.org/page/info/about/policies/terms.jsp
[22] Viitaharju, L., Lähdesmäki, M. (2012) Antecedents of trust in asymmetrical business relationships, Marketing Intelligence & Planning, 30(5), 567–587. https://doi.org/10.1108/02634501211251061
[23] Juan Ding, M., Jie, F. A., Parton, K. J., Matanda, M. (2014) Relationships between quality of information sharing and supply chain food quality in the Australian beef processing industry, The International Journal of Logistics Management, 25(1), 85–108. https://doi.org/10.1108/IJLM-07-2012-0057
[24] Laeequddin, M., Sahay, B. S., Sahay, V., Abdul Waheed, K. (2010) Measuring trust in supply chain partners' relationships, Measuring Business Excellence, 14(3), 53–69. https://doi.org/10.1108/13683041011074218
[25] Batt, P. J. (2003) Building trust between growers and market agents, Supply Chain Management: An International Journal, 8(1), 65–78. https://doi.org/10.1108/13598540310463378
[26] Puspitawati, E., Guyau, A., Stringer, R., Umberger, W. J. (2011) Determinants of Trust in the Indonesian Potato Industry: A Comparison Between Groups of Potato Farmers, Journal of Agribusiness, Agricultural Economics Association of Georgia, 29(1), https://doi.org/10.22004/ag.econ.260160
[27] Fritz, M., Fischer, C. (2007) The Role of Trust in European Food Chains: Theory and Empirical Findings, International Food and Agribusiness Management Review, 10(2), 1–24. https://doi.org/10.22004/ag.econ.8185
[28] Kottila, M.-R. (2009) Knowledge sharing in organic food supply chains, Journal on Chain and Network Science, 9(2), 133–144. https://doi.org/10.3920/JCNS2009.x168
[29] Sako, M. and Helper, S. (1998) Determinants of trust in supplier relations: Evidence from the automotive industry in Japan and the United States, Journal of Economic Behavior & Organization, 34(3), 387–417. https://doi.org/10.1016/S0167-2681(97)00082-6
[30] Kühne, B., Gellynck, X., Weaver, R. D. (2013) The influence of relationship quality on the innovation capacity in traditional food chain", Supply Chain Management: An International Journal, 18(1), 52–65. https://doi.org/10.1108/13598541311293177
[31] Chen, I. J., Paulraj, A., Lado, A. A. (2004) Strategic purchasing, supply management, and firm performance, Journal of Operations Management, 22(5), 505–523. https://doi.org/10.1016/j.jom.2004.06.002
[32] Kottila, M.-R., Rönni, P. (2008) Collaboration and trust in two organic food chains, British Food Journal, 110(4/5), 376–394. https://doi.org/10.1108/00070700810868915
[33] Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., Zacharia, Z. G. (2001) Defining supply chain management, Journal of Business Logistics, 22(2), 1–25. https://doi.org/10.1002/j.2158-1592.2001.tb00001.x
[34] Lee, H. L., Padmanabhan, V., Whang, S. (1997) Information Distortion in a Supply Chain: The Bullwhip Effect. Management Science, 43(4), 546–558. https://doi.org/10.1287/mnsc.43.4.546
[35] Barney, J. (1991) Firm resources and sustained competitive advantage, Journal of Management, 17(1), 99–120. https://doi.org/10.1177%2F014920639101700108
[36] Mutonyi, S., Beukel, K., Gyau, A., Hjortsø, C. N., Griffith, C. (2016) Price satisfaction and producer loyalty: the role of mediators in business to business relationships in Kenyan mango supply chain, British Food Journal, 118(5), 1067–1084. http://dx.doi.org/10.1108/BFJ-09-2015-0319
[37] Lobo, A., Leckie, C., Li, C. (2013) The impact of guanxi, xinyong and buyer collaboration on the loyalty and financial performance of vegetable farmers in China, Asia Pacific Journal of Marketing and Logistics, 25(5), 745–764. https://doi.org/10.1108/APJML-01-2013-0018

[38] Dania, W. A. P., Xing, K., Amer, Y. (2018) Collaboration behavioural factors for sustainable agri-food supply chains: A systematic review, Journal of Cleaner Production, 186 (June), 851–864. https://doi.org/10.1016/j.jclepro.2018.03.148
[39] Wu, I.-L., Chuang, C.-H., Hsu, C.-H. (2014) Information sharing and collaborative behaviors in enabling supply chain performance: A social exchange perspective. International Journal of Production Economics, 148, 122–132. https://doi.org/10.1016/j.ijpe.2013.09.016
[40] Capaldo, A., Giannoccaro, I. (2015) Interdependence and network-level trust in supply chain networks: A computational study. Industrial Marketing Management, 44, 180–195. http://dx.doi.org/10.1016/j.indmarman.2014.10.001
[41] Hobbs, J. E. (1996) A transaction cost approach to supply chain management, Supply Chain Management, 1(2), 15–27. https://doi.org/10.1108/13598549610155260
[42] Aramyan, L. H., Oude Lansink, A. G. J. M., van der Vorst, J. G. A. J., van Kooten, O. (2007) Performance measurement in agri-food supply chains: a case study, Supply Chain Management: An International Journal, 12(4), 304–315. https://doi.org/10.1108/13598540710759826
[43] Ghosh, A., Fedorowicz, J. (2008) The role of trust in supply chain governance, Business Process Management Journal, 14(4), 453–470. https://doi.org/10.1108/14637150810888019
[44] Van der Vorst, J. G. A. J. (2000) Effective food supply chains: generating, modelling and evaluating supply chain scenarios, PhD-thesis Wageningen University, https://edepot.wur.nl/121244
[45] Gunasekaran, A., Patel, C., Tirtiroglu, E. (2001) Performance measures and metrics in a supply chain environment, International Journal of Operations & Production Management, 21(1/2), 71–87. https://doi.org/10.1108/01443570110358468
[46] Singh, R. K. (2014) Assessing Effectiveness of Coordination in Food Supply Chain: A Framework, International Journal of Information Systems and Supply Chain Management, 7(3), 104–117. https://doi.org/10.4018/ijisscm.2014070105
[47] Jie, F., Parton, K. A., Cox, R. J. (2013) Linking supply chain practices to competitive advantage, British Food Journal, 115(7), 1003–1024. https://doi.org/10.1108/BFJ-10-2010-0181

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CHAPTER 14

Sustainability of agri-food supply chains

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The agri-food system is the central and leading sector of every economy, both in developed and developing countries. Demand for food in the world is constantly growing and, accordingly, food chains are developing more and more, leaving behind negative consequences for the environment and society. For example, with regard to food production, the FAO (Sustainability Pathways[1] states that *"global food production must increase by 60% by 2050 to meet the demands of a growing world population."* Consequently, global sustainability expectations in governments and policy makers have been developing sustainable development strategies and establishing frameworks for sustainable consumption and production, and consumers are also increasingly emphasizing the ethical and environmental values of the products they consume[2].

Sustainable food production and distribution is one of the most important problems in developed and developing countries. Market regulation, the emergence of global companies and changing patterns of consumer behavior when buying and consuming food (e.g. demand for off-season products) are just some of the factors that significantly affect agri-food supply chains. Food supply chains from the primary farmer to the final consumer create a direct impact on the environment through the production, processing, transport, storage and preparation of food, generating significant amounts of food waste and food losses. AFSCs need to become not only more efficient and affordable, but also more sustainable and resilient. The long-term sustainability of this system requires the joint and integrated cooperation of all stakeholders in the food supply chain including economic, technological, organizational, social and environmental aspects in the strategic planning and design of sustainable AFSCs.

14.1 Sustainable agri-food supply chains

According to the definition given by Seuring and Müller[3], Sustainable Supply Chain Management (SSCM) can be defined as "management of material, information and capital flows as well as cooperation between companies along the supply chain, while achieving objectives from all levels of sustainable development, i.e. economic, environmental and social, in accordance with the means".

One of the most frequently cited definitions of sustainability is *„triple bottom line"* (TBL) model, introduced by Elkington[4], which divides sustainability into three basic points: a) economic prosperity; b) environmental quality; and c) social equality. All three basic points and their interaction must be taken into account when designing sustainable agri-food supply chains. The three dimensions of TBL can be further distinguished

with respect to financial and nonfinancial economic performance, environmental performance related to input and output performance, and internal and external social performance of SC (Table 1)[5, 6].

Table 1. *Economic, environmental and social requirements of stakeholders in the sustainable supply chain of agri-food products*

Gazdasági	Környezeti	Társadalmi
Financial: – low operating costs – big income – high productivity – high yield – fair distribution of profits in the supply chain Non-financial: – high level of service – high production efficiency – optimal distribution (distance reduction) – high quality products – fair purchasing processes (increasing the number and variety of suppliers) – support to chain partners (support and monitoring for the acquisition of sustainability certificates, knowledge and technology transfer, information exchange, etc.)	– solid waste reduction – small amount of wastewater – low energy consumption – reduction of air pollution – low greenhouse gas emissions (CO_2, methane, etc.) – soil conservation – animal welfare – green processing, packaging and transport	External: – increase social welfare (volunteering, donations) – public health care – support for economic development in local communities – fair trade and transparency – high social protection and justice – easier access to financial and non-financial support – improved product quality and food safety Interior: – better working conditions – employee health and safety – fair employment – elimination of illegal and child labor – staff training – fair wages

Source: Author's work according to León-Bravo et al. and Rebs et al.[5, 6]

Activities and processes of sustainable supply chain management include prevention and reduction of environmental impact, waste reduction, use of environmentally friendly materials wherever possible, recycling and reuse, cooperation with suppliers and other chain partners on sustainability, energy conservation, increasing transparency and traceability in the food supply chain, etc.

There are significant differences in the degree to which organizations and supply chain stakeholders are successfully involved in sustainable supply chain management projects. Certain types of organizations are more or less internally or externally motivated to engage in sustainable supply chain management. This often depends on both the values and the cultural context of the supply chain members. In the supply chain, there are usually companies that have more influence than other companies in the same supply chain and where determining the strategic importance of sustainability aspects can be directly related to competitive advantage. Such companies will make efforts to ensure that other members of the chain adopt sustainability strategies as an integral part of their business strategy. Retailers often play a central role in food supply chains by linking primary production and processing with consumers[7] and dictating market conditions that include sustainability elements such as quality standards, environmental management system, etc. In addition, retailers in collaboration with the food industry, for example, must be prepared to demonstrate responsible sustainable practices while offering more environmentally friendly products.

Sustainable patterns of consumption and production in a world of limited resources are an essential prerequisite for sustainable development, as recognized by experts at the World Summit on Sustainable Development, Rio + 20 (Rio Earth Summit). Achieving sustainable consumption and production patterns is not just an environmental issue; it is about maintaining natural capital, and thus the productivity and ability of our planet to meet human needs and sustain economic activities[8]. According to the United Nations Environment Program (UNEP), one of the most striking examples of consumption and production disfunction is the issue of food loss and waste.

Approximately one-third of all food produced in the world, worth about $ 1 trillion, is lost or wasted in food production or consumption[9]. Almost half of the total food wasted, about 300 million tonnes a year, is due to the fact that producers, retailers and consumers reject food that is still fit for consumption. At the Rio + 20 conference in 2012, world leaders adopted a 10-year framework for programs to enhance inter-

national cooperation and support Sustainable Consumption and Production (SCP) initiatives in developed and developing countries. In this context, it was stated that in order to achieve sustainable development, the SCP must have a high priority. To achieve this, UNEP[10] presented eight Sustainable Development Goals (SDGs), some of which are:

- Implement the 10-year framework of the Sustainable Consumption and Production Program – all countries are taking action and developed countries are taking the lead, taking into account the development and capabilities of developing countries.
- Achieve sustainable management and efficient use of natural resources by 2030.
- By 2030, global food waste per capita should be halved at retail and consumer levels and food losses along production and supply chains, including post-harvest losses, reduced.
- Achieve environmentally sound management of chemicals and all waste during their life cycle by 2020 in accordance with agreed international frameworks and significantly reduce their release into the air, water and soil to reduce their harmful effects on human health, the environment.
- By 2030, significantly reduce waste generation through prevention, reduction, recycling and reuse.
- Companies, especially large and transnational ones, to adopt sustainable practices and integrate sustainability information into their reporting cycle.
- Promote public procurement practices that are sustainable in line with national policies and priorities.
- By 2030, ensure that people everywhere have relevant information and awareness for sustainable development and lifestyles in harmony with nature.

14.1.1 Opportunities and obstacles to sustainable Agri-Food Supply Chains

Organizations that want to sustainably manage the supply chain face internal and external barriers and opportunities[11].

Internal obstacles are: lack of management involvement, high costs, measuring efficiency, company size (smaller companies), lack of education, lack of understanding of the matter and lack of processes in the company that would incorporate sustainable supply chain management.

External obstacles are: regulations by the state, competitive pressure, consumer pressure at the lowest possible prices, insufficient supplier engagement and media influence.

Internal opportunities are: commitment of management, positive engagement of employees, involvement of middle management, positive impact on company culture, competitive advantage of the company, sustainable image of the company and improving the quality of business.

External opportunities are: incentives from the state, competition, a positive image of the company in the eyes of consumers, an opportunity to improve relations with suppliers, positive reactions from investors.

According to Dania et al.[12], 10 key behavioral factors have been identified that enable an effective cooperation system for sustainable agri-food supply chain management, namely: joint efforts, sharing activities, value of cooperation, adaptation, trust, commitment, fair distribution of power, continuous improvement, coordination and stability.

One of the key questions for the future of the food system will be "how to manage the transition to a sustainable system that can deliver the desired amount of food at the same time?" Accordingly, Ambler-Edwards et al.[13] identified four characteristics with increasing importance in the future food supply chain:

1. *Resilience* – a system that can ensure long-term availability in light of growing global insecurity
2. *Sustainability* – a system that can deliver safe, healthy food with positive social benefits and low environmental impact
3. *Competitiveness* – a system capable of delivering affordable food at potentially higher base costs
4. *Management of consumer expectations* – a system that is designed and meets the wishes of consumers in accordance with social needs

Indicators of how the current characteristics of the agri-food system should change were presented by Ambler-Edwards et al.[13], citing some of the new sustainability requirements for all actors in the AFSC at the following levels:

1. *Agriculture system* – systems optimized with low input / high output; high level of experimentation and innovation; waste reuse; structural (instead of direct) support for investment, knowledge transfer and access to technology; competitiveness through horizontal models of cooperation; increasing the size of agricultural holdings together with the separation of ownership and production; optimizing resources in line with sustainable goals; minimizing losses throughout the system through horizontal production networks and vertical supply chain efficiencies.
2. *Supply process* – risk management based on the system; crisis management throughout the chain; common measurement systems based on cost competitiveness; compliance with public requirements for resilience and sustainability; resource efficiency; integration and management of waste streams with product streams.
3. *Products* – rationalization of products and preparation of choice, based on higher standards and consumer requirements; use of substitutes and alternative ingredients.
4. *Assets and structures* – more flexible use of assets; increased investment in smaller assets; new assets related to waste reuse leading to more horizontal cooperation, especially in producer networks; investment decisions based on total cost of ownership (including environmental costs); national models developed together with regional sources overlap with efficient distribution models; inefficient local models replaced by local solutions integrated with existing efficient distribution models.
5. *Supply chain relations* – better horizontal cooperation relations; better vertical cooperation; long-term supply contracts in which power is balanced; partnerships with other sectors/industries; connecting the entire chain, from farm to consumer; cooperation with all stakeholders in the chain.
6. *Strategies* – growth of competitiveness based on low environmental impacts.

In essence, cooperation is a key way to achieve a balance between all sustainability goals, by mitigating the individualistic and opportunistic behavior of stakeholders in the supply chain. Effective and quality cooperation for sustainable agri-food supply chains can facilitate farmers' access to resources, opportunities and benefits equal to those of other stakeholders in the supply chain[5, 12, 14].

14.1.2 Measuring sustainability

Measuring the degree of sustainability of the food supply chain can be difficult to achieve because measuring economic performance, environmental and social responsibility is difficult to quantify, especially because multiple actors are involved in the chain[5].

Using the TBL concept as a basis, sustainability measurement can be carried out in three areas[15]:

1. *Economic sustainability:* financial measures (cost-effectiveness, return on investment, etc.);
2. *Environmental sustainability:* measuring the impact of companies and processes (environmental footprint, carbon emissions, packaging waste, fuel consumption, energy consumption, eco-labeling, etc.);
3. *Social sustainability:* measures social impact (working conditions, wage scales, investment in community, fair and ethical prices, etc.).

Measuring efficiency can also be achieved on the basis of a balanced scorecard (BSC) which includes financial as well as non-financial aspects. It relies on four processes to link short-term activities with long-term goals: implementing the vision; communication and networking; business planning; feedback and learning. It aims to promote integration through business functions, supply chain partnerships, flexibility and continuous improvement[16]. The strategic objectives are formulated within four perspectives (with indicators or performance measures) with the aim of aligning between strategy, business capacity, accountability and financial success in sustainable supply chain management based on environmental protection[17].

1. *Financial perspective*
   The indicators are: return on invested funds, capital investments, operating expenses, disposal costs, revenues from recycling, income from "green" products, fines, avoidance of costs due to environmental actions, etc.

2. *Perspective of internal processes*
   Indicators are: percentage of recycled production and office supplies; authorized suppliers; accidents and disasters, internal audit assessment, energy consumption, percentage of certified facilities, percentage of processed products, energy use, greenhouse gas emissions, hazardous material output, etc.
3. *Learning and growth perspective*
   Indicators are: percentage of trained employees, community complaints, use of renewable sources, violations reported by employees, employees with incentives related to environmental goals, functions with responsibilities for environmental protection, emergency response programs and the like.
4. *Customer perspective*
   Indicators are: green products, product safety, recall, customer returns, unfavorable reporting in the press, the percentage of products returned after use, environmental performance of functional products, etc.

14.2 Ethical issues in Agri-Food Supply Chains

In the academic literature, sustainable supply chain management often includes ethical issues in agri-food supply chains and closely related areas such as corporate social responsibility (CSR), green supply chain management (GSCM), value chain management, ethical and environmental purchases, adherence to ethical standards in the use of labor (labor and human rights), the origin, quality and safety of food, and problems related to food loss and food waste.

The globalization of agri-food markets, together with free trade policy, has greatly improved the verification of food origin, quality, safety, nutritional and health properties, as well as the ethics followed to achieve sustainable food production[18].

14.2.1 Food losses and food waste

In Europe and the world, there is a growing awareness of the issues related to food losses, food waste and irrational consumption of resources for food production, especially because it is not only about the environment but also about socio-economic and moral issues. A large number of countries, precisely in order to prevent the generation of food waste, have begun to collect more intensive data and information on this type of waste, define measures to prevent its generation and work on education and public information.

Food is wasted at all stages of the food supply chain from the initial stages of production to the final stage of consumption. Food waste in the initial stages is due to a lack of efficient physical infrastructure and technologies for post-harvest production, harvesting and processing, while food waste in the last stages of the food supply chain takes place through retail, catering and consumption[19]. Food waste creates environmental, social and economic costs[20].

It is necessary to distinguish two basic concepts that occur with the problem of food waste. These are food loss and food waste.

Food loss is common in every food supply chain and occurs during the production, storage and processing stages. Food loss is a reduction in the amount of edible food in the supply chain intended for human consumption[21]. It is the amount of edible food that is available for human consumption but for some reason is not consumed. Knežević et al.[22] point out that food losses "occur in the stages of production, storage, processing and physical distribution as an unwanted consequence of business processes or technical constraints in storage, infrastructure, packaging or marketing activities." More efficient application of measures to prevent losses in the initial part of the food supply chain means a reduction in the harmful impact on the environment, but also less food losses. Additional risks of spoilage occur during transport, preparation, distribution and consumption of food, which means that we can talk about the accumulation of negative environmental impacts and the risk of losses. The main drivers of food loss are infrastructure constraints, climatic and environmental factors, and the assessment of quality or safety standards[23].

Food waste means food losses at the end of the food supply chain, i.e. in retail and final consumption. Food waste mainly occurs as a result of conscious behavior by both traders and consumers[21]. Food waste means food that is fit for consumption and has the appropriate quality, but has not been consumed due to some human factors. Food waste occurs when food that was originally produced for human consumption is either removed in vain or not consumed by humans. These include food that was spoiled before disposal and food that was still edible when discarded[24]. The consequence of not consuming such food is that food is thrown away before or after it spoils[25].

Furthermore, according to the British charity *Waste & Resources Action Program (WRAP),* there are three categories of food waste[26]:

5. *Avoidable food waste* – refers to food that has been discarded and that was fit for consumption before being discarded (eg bread, meat, apple, etc.).
6. *Food waste that may have been avoided* – food that some people consume and other people do not (eg crust of bread) or food that, depending on the preparation, may or may not be edible (eg potato peel, etc.).
7. *Food waste that cannot be avoided* – refers to waste generated during food preparation that is not edible or was edible (bones, egg shells, pineapple peel, tea bags, etc.).

Thus, the difference between these concepts is in the fact that food losses occur unintentionally and food loss is due to reduced food quality. On the other hand, food waste is generated intentionally, i.e. it occurs as a result of conscious food waste or irresponsible behavior of traders or consumers.

Some of the main causes of food loss and waste can be divided according to the phase in the AFSC[23, 27] (Table 2):

Table 2. *Main causes of food loss and waste*

Loss phase in AFSC	Causes of food loss
On the farm	■ Excessive production ■ Unharvested products remain in the field ■ Bad prediction ■ Strict demand for quality ■ Demand for a certain size ■ Poor infrastructure ■ Lack of scientific techniques ■ Poor breeding techniques ■ Lower quality harvesting equipment ■ Failure to meet quality standards set by other stakeholders ■ Weather changes
Food processing	■ Lack of training / poor processing ability ■ Product defects ■ Poor packaging / Use of poor packaging ■ Imposed standards ■ Cosmetic defects ■ Loss due to inefficient processing techniques ■ Loss of crops / crops that are not visually aesthetic ■ Improper handling techniques
Storing	■ Poor infrastructure / lack of storage space ■ Inadequate cooling storage / lack of cold chain facilities ■ Microbial infection ■ Pest and mold attacks

Distribution and retail or wholesale	■ Logistic constraints ■ Poor cold chain management ■ Strict customer requirements regarding product size and quality ■ Food safety ■ Expiry date ■ Excessive stock ■ Lack of information exchange ■ Bad prediction ■ Incorrect ordering ■ Low price offered to manufacturers ■ Lack of refrigerators ■ Damaged logistics infrastructure ■ Long distance distribution ■ Poor road infrastructure ■ Low price offered to manufacturers ■ Pathological loss
Hospitality / service industry (HoReCa)	■ Operational barriers ■ Lack of staff ■ Infrastructure ■ Dining environment ■ Lack of staff capacity ■ Employees do not identify portion sizes ■ Bad menu
Consumption	■ Growing prosperity ■ Increasing employment ■ Consumer preferences ■ Strong focus on freshness ■ Household behavior ■ Incorrect purchase planning ■ Lack of knowledge to reuse leftovers

Source: Author's work according to Dora, M. et al. and Despoudi, S.[23, 27]

However, there are significant differences in the creation of food losses between developed and less developed countries. In developed countries, there is a large amount of food loss at the retail stage due to high quality standards, rejection of foods that are not in perfect shape or appearance or that exceed the expiration date, and due to inaccurate demand forecasts. At the consumer level, inefficient purchase planning, misinterpretation of expiration and expiration dates, cooking large meals and lack of later use contribute to large amounts of waste. They are associated with the careless attitude of some consumers who can afford to waste food. On the other hand, in less developed countries, food loss occurs mainly in the upstream stages of the food supply chain, ie in production, post-harvest handling, processing and storage due to lack of financial, technical and managerial resources. Poor harvesting techniques, lack of storage and refrigeration capacity, and inadequate infrastructure and packaging are the main causes of food loss in the least developed countries[23].

In contrast, in the developed world, losses usually occur in further stages of the food supply chain due to cultural, social and economic decisions made by producers, traders and final consumers[23].

The analysis[27] revealed five main categories of challenges in reducing food losses at the producer level, namely: lack of technology adoption, lack of understanding of changing market demands and changing regulations, lack of agricultural skills and the need for modern agricultural practices, cooperation issues and the impact of climate change. The impact of climate change as well as cooperation have been major challenges in reducing food losses.

Looking at the comprehensive issues related to food waste, the concept of preventing the generation of this type of waste and assessing its impact on the environment should be based on an approach that includes the entire life cycle of the product. The life cycle includes primary (agricultural) production, handling and storage after harvest, processing, distribution, consumption and completion of the life cycle, ie obtaining waste status.

Here is an example of food waste in five basic stages of the vegetable supply chain:

- *Agricultural production* – food waste due to mechanical damage / spoilage due to harvest, sorting after harvest
- *Storage and handling of goods after harvest* – includes disposal due to spoilage and handling, storage and transport errors between farm and distribution
- *Processing* – includes waste due to spoilage and errors in industrial or domestic processing (juice production, canning, meal preparation)
- *Distribution* – includes throws and losses in the market system (supermarkets, retailers, wholesale)
- *Consumption* – includes losses and waste of food by consumers when consumed at the household or catering level

14.2.2 Socially responsible behavior

The purpose of existence and the main goal of every company is successful business, and this largely depends on the adoption and application of good management practice[28]. The business of a company takes place in a certain community that has its own expectations and rules, within a limited natural environment, in a market affected by various factors, with employees who have their own aspirations and increased sensitivity of customers to social and environmental issues. Businesses can make a significant contribution to the progress of the economy, the environment and society, but they must also ensure the management of the adverse effects associated with their business.

Therefore, companies are increasingly applying good corporate social responsibility (CSR) practices. CSR definitions are listed, all of which include the principle of sustainability based on the three dimensions of TBL.

CSR is defined as "a concept by which companies integrate social and environmental issues into their business and interact with their stakeholders on a voluntary basis"[29].

"CSR is defined as the management of stakeholder concerns about responsible and irresponsible acts related to environmental, ethical and social phenomena in a way that creates corporate benefit"[30].

According to ISO 26000 CSR is defined as ". . . The organization's responsibility for the effects of its decisions and activities on society and the environment, through transparent and ethical behavior that contributes to sustainable development, including health and well-being of society, takes into account stakeholder expectations, complies with applicable law and international standards of conduct that is integrated and practiced in the relations of the organization"[1].

Although the concept of CSR can be considered voluntary at the organizational level, many aspects of CSR in the food supply chain relate to minimum legal compliance, for example, food safety, animal welfare, environmental protection and employment law, and employee health and safety[28]. Therefore, compliance with legislation as the basis of CSR is not enough in itself, but the essence of CSR is that in relation to the environment and society, it goes beyond what is prescribed by law, shaping the behavior of companies.

Corporate social responsibility is of great importance to AFSC stakeholders as this sector has a strong influence and high dependence on the economy, environment and society. Given the characteristics of the AFSC, the implementation of CSR practice becomes even more complex. Important issues and areas of CSR in the AFSC are[31]: animal welfare; biotechnology; environmental care; fair trade; health and safety; labor and human rights; threats to animals, humans and the environment through procurement and accountability to the community. In addition, issues of food safety and quality and food loss and waste can be added, especially in the retail phase[32].

In the context of CSR, the food sector faces particular challenges, in particular for three reasons:

1. The food sector is highly influential and highly dependent on natural, human and physical resources[33]. This leads to a complex set of requirements for the food sector relating to the production of raw materials (animal welfare), the environment (eg energy and water use; waste) and social (working conditions) conditions along the whole value chain, as well as quality, health and safety product.

[1] Guidance on social responsibility (ISO 26000: 2010). Berlin.

2. Food covers basic human needs, and consumers today have a strong attitude about what they eat. This is where the role of consumer ethics and purchasing behavior comes into play (eg consumers look at animal welfare and the impact of business on the environment in addition to food quality and safety). According to Rode et al[34], consumers are willing to pay a premium for ethical products and therefore ethical producers will recoup higher production costs.
3. The food chain has a unique and multiple structure. As small and large enterprises differ in their approach to CSR, and this implies potential conflicts over the inclusion of CSR in the food supply chain. Spence and Bourlakis[35] even consider CSR "an inadequate concept for achieving the required level of social responsibility for the whole supply chain to be critical in today's complex and integrated economic context" and suggest a new approach called "Supply Chain Responsibility" – SCR). They explain this by the fact that AFSC problems arise because the last member of the supply chain facing end customers does not have complete information about the behavior of their suppliers and subcontractors and is unable to control how they do business and how much they apply CSR principles. The threats and opportunities of CSR are increasingly shifting from the level of one company to food supply chains and the food network[36].

The impact of CSR and corporate social responsibility of AFSC stakeholders affects consumer perception and behavior and is manifested through: the assessment and reputation of the company or brand; credibility of the company; consumer or customer loyalty; consumer confidence and satisfaction; the intention to purchase the product. In addition, CSR has been shown to be positively associated with the reputation of companies sought by employees, a sense of closeness and identification with the company, and the company's attractiveness as an employer[36].

Accordingly, CSR can be conceptually and empirically linked to at least three dimensions: intra-organizational, business-to-business B2B, and business-to-society B2S[30].

The current global business environment motivates organizations to consider all the social and ethical impacts of their corporate activities and policies. Organizations capable of demonstrating a responsible approach to broader social and ethical issues will gain a significant competitive advantage and inspire the trust of stakeholders such as customers, investors, the local community and consumers.

Bibliography

[1] FAO (Sustainability Pathways. Dostupno online: http://www.fao.org/nr/sustainability/food-loss-and-waste/en/
[2] Bourlakis, M. A., Weightman, P. W. H. (2004) Food Supply Chain Management, School of Agriculture, Food and Rural Development, University of Newcastle upon Tyne, UK, Blackwell Publishing Ltd., ISBN: 978-1-405-10168-4, https://doi.org/10.1002/9780470995556
[3] Seuring, S., Müller, M. (2008) From a literature review to a conceptual framework for sustainable supply chain management. Journal of Cleaner Production, 16(15), 1699–1710. https://doi.org/10.1016/j.jclepro.2008.04.020
[4] Elkington, J. (1998) Cannibals with Forks: The Triple Bottom Line of the 21st Century. Stoney Creek/CT: New Society Dotupno online: https://www.sdg.services/uploads/9/9/2/1/9921626/cannibalswithforks.pdf
[5] León-Bravo, V., Caniato, F., Caridi, M., Johnsen, T. (2017) Collaboration for Sustainability in the Food Supply Chain: A Multi-Stage Study in Italy. Sustainability, 9(7), 1253. https://doi.org/10.3390/su9071253
[6] Rebs, T., Brandenburg, M., Seuring, S. (2018) "System dynamics modeling for sustainable supply chain management: A literature review and systems thinking approach", Journal of Cleaner Production, 208 (January), 1–33. https://doi.org/10.1016/j.jclepro.2018.10.100
[7] Fritz, M., Schiefer, G. (2008) "Food chain management for sustainable food system development: a European research agenda", Agribusiness, 24(4), 440–452. https://doi.org/10.1002/agr.20172
[8] Govindan, K. (2018). Sustainable Consumption and Production in the Food Supply Chain: A Conceptual Framework. International Journal of Production Economics, 195, 419–431. https://doi.org/10.1016/j.ijpe.2017.03.003
[9] UNEP (2015a) Sustainable Consumption and Production and the SDGs, dostupno na: https://wedocs.unep.org/bitstream/handle/20.500.11822/9705/-Sustainable_consumption_and_production_and_the_SDGs_UNEP_Post_2015_Note_2-2014sustainable_consumption_and_production_and_the_SDG_english.pdf.pdf?sequence=8&isAllowed=y (Prestupljeno 29. 09. 2021)
[10] UNEP (2015b). SCP indicators for the future SDGS Discussion Paper, dostupno na: https://www.unep.org/resources/report/sustainable-consumption-and-production-indicators-future-sdgs-unep-discussion (Prestupljeno 29.09.2021)
[11] Walker, H., Jones, N. (2012) Sustainable supply chain management across the UK private sector. Supply Chain Management: An International Journal, 17(1), 15–28. http://dx.doi.org/10.1108/13598541211212177
[12] Dania, W. A. P., Xing, K., Amer, Y. (2018) "Collaboration behavioural factors for sustainable agri-food supply chains: A systematic review", Journal of Cleaner Production, 186 (June), 851–864, https://doi.org/10.1016/j.jclepro.2018.03.148
[13] Ambler-Edwards, S., Bailey, K. S., Kiff, A., Lang, T., Lee, R., Marsden, T. K. i sur. (2009) Food futures: Rethinking UK strategy. A Chatham

House reportUK, The Royal Institute of International Affairs Chatham House, ISBN 978 1 86203 211 8
[14] Touboulic, A., Walker, H. (2015) "Love me, love me not: A nuanced view on collaboration in sustainable supply chains", Journal of Purchasing and Supply Management, 21(3), 178–191. https://doi.org/10.1016/j.pursup.2015.05.001
[15] Dani, S. (2015) Food Supply Chain Management and Logistic From farm to fork, London, Philadelphia & New Delhi: Kogan Page, ISBN 978 0 74947364 8
[16] Kaplan, R. S., Norton, D. P. (2007) Using the Balanced Scorecard as a strategic management system. Harvard business review, 85(7/8), 150–161.
[17] Mishra, D., Gunasekaran, A., Papadopoulos, T. and Hazen, B. (2017) Green supply chain performance measures: A review and bibliometric analysis. Sustainable Production and Consumption, 10, 85–99. https://doi.org/10.1016/j.spc.2017.01.003
[18] Accorsi, R., Manzini, R. (2019) Sustainable Food Supply Chains1st Edition, Planning, Design, and Control through Interdisciplinary Methodologies, Academic Press, Elsevier Inc. ISBN 978-0-12-813411-5
[19] Karki, S. T., Bennett, Alice C. T., Mishra, Jyoti L. (2021) Reducing food waste and food insecurity in the UK: The architecture of surplus food distribution supply chain in addressing the sustainable development goals (Goal 2 and Goal 12.3) at a city level, Industrial Marketing Management, 93, 563–577. https://doi.org/10.1016/j.indmarman.2020.09.019
[20] Mullick, S., Raassens, N., Haans, H., Nijssen, E. J. (2020) Reducing food waste through digital platforms: A quantification of cross-side network effects. Industrial Marketing Management. https://doi.org/10.1016/j.indmarman.2020.09.021
[21] Parfitt, J., Barthel, M., Macnaughton, S. (2010) Food waste within food supply chains: Quantification and potential for change to 2050. Philosophical Transactions of The Royal Society, 365 (1554), 3065–3081. https://doi.org/10.1098/rstb.2010.0126
[22] Knežević, B., Marić, I., Šućur Z. (2017) Međusektorska suradnja u području distribucije hrane kao odgovor na probleme siromaštva i materijalne deprivacije, pregledni rad. Revija za socijalnu politiku, 24(2), 143–167. https://doi.org/10.3935/rsp.v24i2.1410
[23] Dora, M., Biswas, S., Choudhury, S., Nayak, R., Irani, Z. (2021) A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain, Industrial Marketing Management, 93, 492–508. https://doi.org/10.1016/j.indmarman.2020.10.013
[24] Thyberg, K. L., Tonjes, D. J. (2016) Drivers of food waste and their implications for sustainable policy development. Resources, Conservation and Recycling, 106, 110–123. https://doi.org/10.1016/j.resconrec.2015.11.016
[25] Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., Searchinger, T. (2013) Reducing food loss and waste. Working paper of World Resources Institute. Washington, DC. Dostupno na: https://www.wri.org/publication/reducing-food-loss-and-waste
[26] WRAP (2011) New estimates for household food and drink waste in UK, Dostupno na: https://wrap.org.uk/resources/report/estimates-household-food-and-drink-waste-uk-2011#
[27] Despoudi, S. (2021) Challenges in reducing food losses at producers' level: the case of Greek agricultural supply chain producers, Industrial Marketing Management, 93, 520–532. https://doi.org/10.1016/j.indmarman.2020.09.022
[28] Lindgreen, A., Hingley, M. K.,Vanhamme, J. (Eds) (2009) The Crisis of Food Brands: Sustaining Safe, Innovative, and Competitive Food Supply, Gower Publishing, Aldershot, ISBN 978-0-566-08812-4
[29] Commission of the European Communities (2001) "Green Paper. Promoting a European framework for corporate social responsibility" dostupno na: https://ec.europa.eu/commission/presscorner/detail/en/DOC_01_9
[30] Vaaland, T. I., Owusu, R. A. (2012) What is a Responsible Supply Chain? International Journal of Business and Management, 7(4), https://doi.org/10.5539/ijbm.v7n4p154
[31] Maloni, M. J., Brown, M. E. (2006) Corporate Social Responsibility in the Supply Chain: An Application in the Food Industry. Journal of Business Ethics, 68(1), 35–52. https://doi.org/10.1007/s10551-006-9038-0
[32] Devin, B., Richards, C. (2016) Food Waste, Power, and Corporate Social Responsibility in the Australian Food Supply Chain. Journal of Business Ethics, 150(1), 199–210. https://doi.org/10.1007/s10551-016-3181-z
[33] Genier, C., Stamp, M., Pfitzer, M. (2009) Corporate social responsibility for agro-industries development. In: Da Silva, C., Baker, D., Shepherd, A., Jenane, C., Miranda-da-Cruz, S. (eds), Agro-industries for Development. Oxfordshire, UK: CABI. https://doi.org/10.1079/9781845935764.0223
[34] Rode, J., Hogarth, R. M., & Le Menestrel, M. (2008) Ethical differentiation and market behaviour: An experimental approach. Journal of Economic Behavior & Organization, 66, 265–280. http://dx.doi.org/10.1016/j.jebo.2006.12.003
[35] Spence, L., Bourlakis, M. (2009) The evolution from corporate social responsibility to supply chain responsibility: the case of Waitrose. Supply Chain Management: An International Journal, 14(4), 291–302. https://doi.org/10.1108/13598540910970126
[36] Hartmann, M. (2011) Corporate social responsibility in the food sector. European Review of Agricultural Economics, 38(3), 297–324. https://doi.org/10.1093/erae/jbr031

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CHAPTER 15

Case studies, calculation examples

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15.1 The role of quality and logistics costs in sugar beet procurement (Magyar Cukor Zrt.)

The case study was based on the study of the same title by Horváth, Csonka, Szerb, Csima[1] and presents the raw material supply system of Magyar Cukor Zrt.

15.1.1 The role of quality and logistics costs in sugar beet procurement

Magyar Cukor Zrt.'s sugar beet procurement process system is implemented through five phases from the conclusion of the contract. The campaign-like implementation of these phases is regulated by agreements between the producer association and the sugar factory, based on standards and well-established routines. As a result, in this study we deal less with operational process management, the characteristics of each phase are briefly presented in Table 1.

Table 1. *Organization of sugar beet supply at the Kaposvár sugar factory*

Phase	Characteristics
Contract conclusion	• Rounds of negotiations (2-3) with the National Association of Sugar Beet Growers on contract terms (January) • Signing contracts with producers (February-March)
Production supervision	• documentation of operations during cultivation (obligation of the producer) • the M.C. Zrt. sampling tests and insight into the documentation • watering after August 31 only in extreme weather conditions, the M.C. With the permission of Zrt.
Harvesting and delivery	Duties of producer: • defoliation and cleaning during harvesting • storage next to the board (storage for 3-5 weeks) • providing road transport to the factory or railway loading station M.C. Zrt.'s duties • preparing a delivery schedule (negotiations 2-3 weeks before the campaign) • creation of transport groups (8-10 producers/group) • road freight reimbursement, organization of rail transport
Quantitative and qualitative handover	• acceptance based on the MSZ 17045:2002 standard • RÜPRO probe sampling, laboratory quality testing (M.C. Zrt.) • producers can send an authorized specialist to check the acceptance • protocol in the event of a sampling dispute

Financial Accounting	• The M.C. Zrt. notifies the producer within 5 days after receipt of the details of the receipt log (by mail or e-mail) • The M.C. Zrt. prepares an account within 15 days from the producer's last delivery • payment within 15 days of receipt of the producer's invoice • after the delivery of 50 percent of the contracted quota sugar beet, the producer has the opportunity to take an advance amounting to 50 percent of the expected sales revenue

In the following sub-chapters, we present some raw material supply problems – typically occurring at the tactical and strategic level – that greatly affect the effectiveness of cooperation between agricultural producers and processors in the case of the sugar factory.

15.1.2 The key figures for sugar beet procurement between 2009 and 2016

The development of the sugar beet growing area contracted by Magyar Cukor Zrt. and the quantity of sugar beet delivered is shown in 16.1. figure shows. It can be seen in the figure that during the examined period, the contracted production area was characterized by rather large fluctuations and instability, and after the 2006 sugar reform, the sugar beet market was difficult to consolidate. This fluctuation is a good indication of one of the biggest challenges of beet procurement for the sugar factory in Kaposvár: if the sugar factory wants to use its production capacity to the maximum extent, then it has relatively little scope for supplier selection. The proportion of stable agricultural producers intending to contract with the same volume year after year is relatively small, a significant part of the supply depends on how many of the producers who are less committed to sugar beet cultivation decide to grow sugar beet, given the current price and production cost conditions, and on what area. It is a telling fact that during the period, out of the 490 producers in the supplier base, only 33 delivered sugar beet to the sugar factory every year. The primary driver of the fluctuation is the price development of corn, a competitive species that can be grown at a lower cost and is technologically less demanding. As a secondary reason, the expansion of the Croatian sugar factories near the border towards Hungarian production areas can be mentioned. Many producers enter into shared contracts with both Kaposvár and Croatia processors, and territorial proportions are decided on an annual basis, depending on the purchase price, premiums and other contractual conditions.

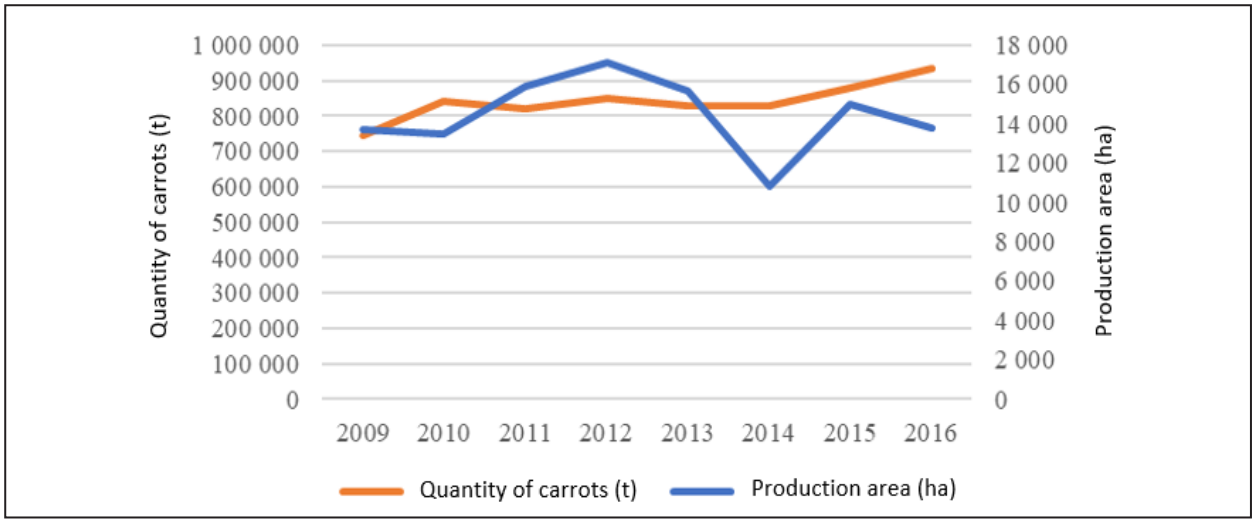

Figure 1. *The development of the contracted production area and the quantity of delivered beets at Magyar Cukor Zrt (2009–2016)*

Despite the fluctuations in the production area, the delivered beet volume was characterized by a balanced growth during the period under review. This phenomenon clearly reflects the fact that after the sugar reform, a "cleansing" process took place in the sector. The more competitive sugar beet producers who remained on the product line – in many cases in cooperation with the processor – were able to develop technology and production management, thanks to which both the average yield and the white sugar yield per hectare increased significantly (see Figure 2).

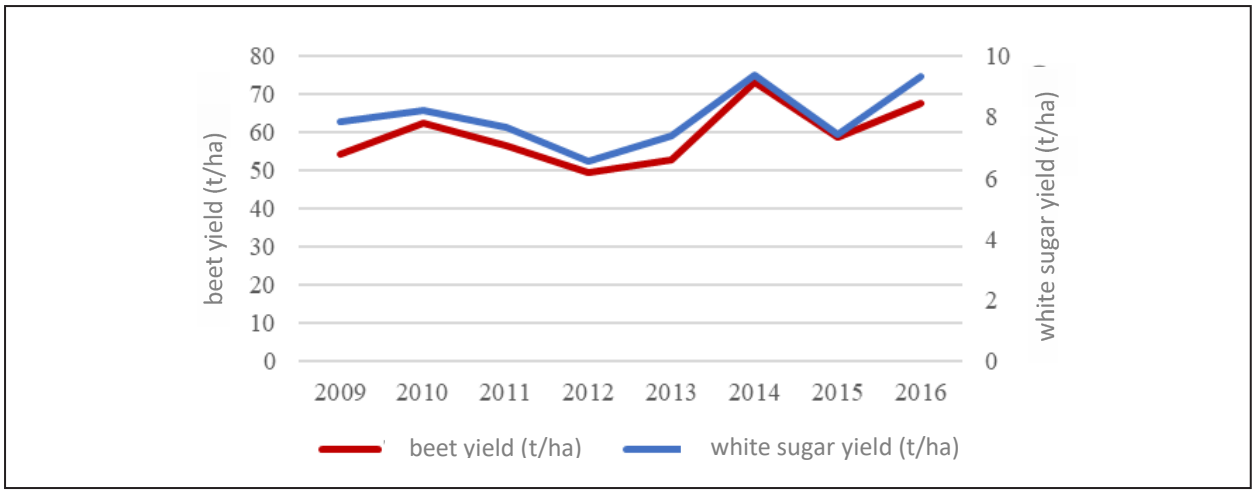

Figure 2. *Average yield and white sugar yield at Magyar Cukor Zrt (2009–2016)*

1. and 2. from the comparison of Fig. 1, it can also be concluded that the development of specific yields – in addition to the rising trend – moved in the opposite direction to the fluctuations of the cultivated area in the individual years. The dramatic increase in the cultivated area caused a decrease in the average yield, and we can also see examples of the opposite. This opposite movement ultimately resulted in the low annual volatility of the delivered beet volume. This phenomenon once again confirms that the supplier base of the Kaposvár sugar factory is characterized by duality. Side by side, there is a stable group of suppliers capable of achieving a relatively higher average yield and sugar yield, with a constant volume, and an unstable group characterized by lower productivity and large fluctuations in the area of production. The latter group carries a greater risk in terms of the security of raw material supply.

As the next element of the examination of supply trends, we present the evolution of the number of suppliers and their average production area (Figure 3).

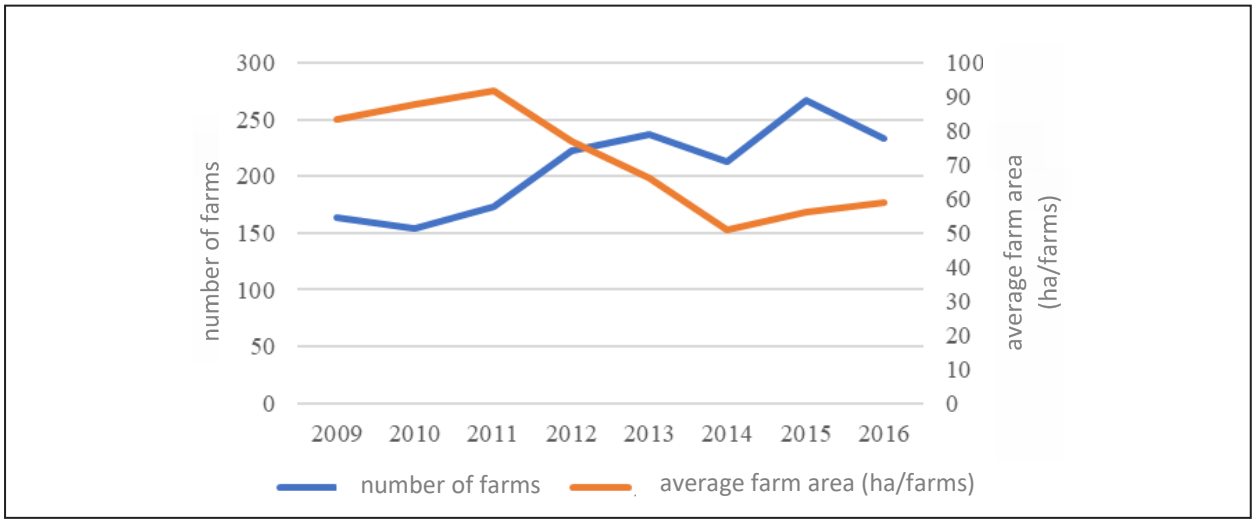

Figure 3. *Development of the number of producers and the average production area at Magyar Cukor Zrt (2009–2016)*

The figure shows that the number of suppliers increased significantly as a result of the intention to increase the supply of raw materials. At the same time, however, the average cultivated area decreased, i.e. compared to previous years, producers contracted for sugar beet cultivation on a significantly smaller area. The decrease in the average cultivated area once again provides another explanation for the fluctuation of suppliers: the smaller the area the producer farms, the less likely it is that sugar beet will be included in the crop structure in each successive year.

Our next question is how the geographical location of the producers and their distance from the sugar factory developed. Since the transport costs are mainly borne by the processor, the transport distance is

of fundamental importance from the point of view of raw material supply. As we wrote earlier, only an extremely small proportion of the mass of sugar beet delivered to the sugar factory is the realizable sugar content. Thus, long-distance delivery can be said to be extremely expensive. Despite this, and due to the previously mentioned low scope for supplier selection, the average transport distance increased during the examined period (Figure 4).

Sugar beet can arrive at the sugar factory via two possible routes: either directly by road or by combined road-rail transport (via the nearest railway station suitable for loading). The figure shows that the average road haulage distance is really low, ranging between 20-26 km in most years. The rail transport distance, and with it the total transport distance, on the other hand, increased sharply between 2009 and 2012, and then stabilized above 250 km. This transport distance can be said to be particularly high in domestic terms. With such transport distances, the specific logistics cost is extremely high: in the examined years, it ranged between 7-8 euros/ton, which is 25-30 percent of the beet's basic purchase price.

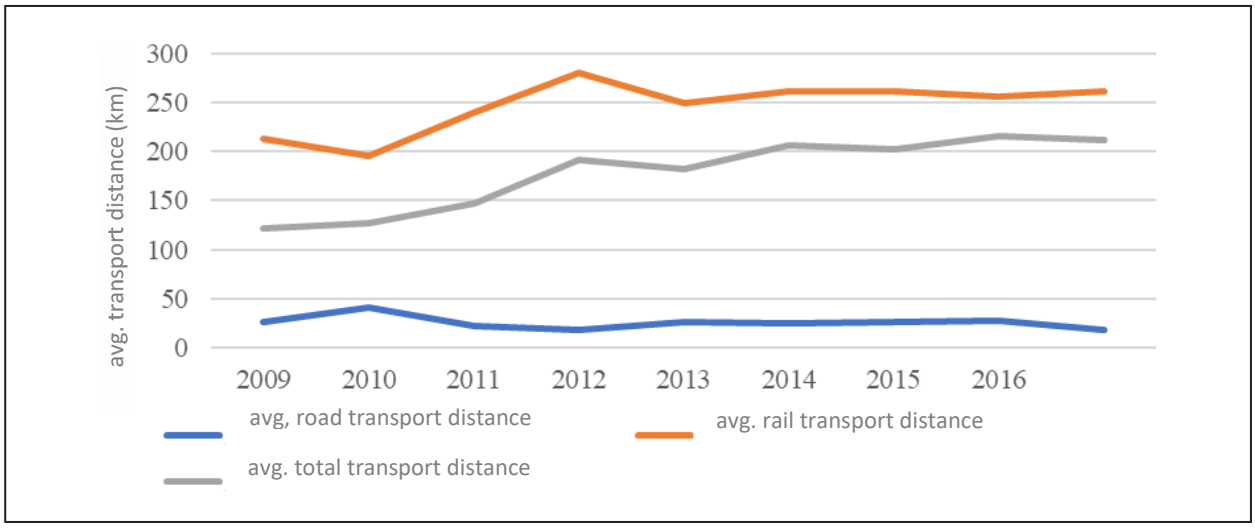

Figure 4. *Development of the average transport distance at Magyar Cukor Zrt (2009–2016)*

15.1.3 Tools to encourage the stability and quality performance of the supplier base at Magyar Cukor Zrt

One of the most important lessons from the previous sub-point is that the Kaposvár sugar factory has little opportunity to select among sugar beet producers, instead it should strive to use tools that encourage stable and permanently high quality. One of the basic ways to do this is to use premiums built into the contract.

The acceptance price of sugar beet, as well as the extent of other producer benefits above the base price, is contained in the Sugar Beet Production and Sales Contract (hereinafter: Contract) concluded annually between Magyar Cukor Zrt. and the producers. The base price established in the contract is set in euros, applies to beets with a sugar content of 16%, and essentially represented the base price set by the EU (26.29 EUR/t) during the period under review. This static price is always complemented by dynamic elements that encourage quality performance and production stability.

On March 26, 2004, the Interprofessional Agreement concluded by the Sugar Industry Association (CIE) and the CTOSZ entered into force[2]. The agreement, which has been in effect ever since with a minor amendment[3], regulates the price adjustment based on the measured sugar content, as follows:

"If the sugar content of the sugar beet at the time of acceptance differs from 16.0 %, then in the event of a change in the exact sugar content of 0.1 %, the minimum sugar beet price:

a) It should be increased:

- 0.9% for sugar content exceeding 16% but not exceeding 18%,
- 0.7% for sugar content exceeding 18% but not exceeding 19%,
- 0.5% for sugar content exceeding 19% but not exceeding 20%;

b) It should be reduced:
- 0.5% for sugar content below 16% but not lower than 15.5%,
- 1.0% for sugar content below 15.5%.

The price of beets with a sugar content greater than 20% is the same as the adjusted price applied for beets with a 20% sugar content.

The sugar factory and the regional association(s) agree separately on the acceptance of sugar beets with a sugar content of less than 14%."

As can be seen, the rate of price increase/decrease in each interval significantly exceeds the rate of increase/decrease in sugar content. This in itself indicates that the pricing system is a great motivation to achieve a higher sugar content. We can get a more accurate picture of this by using a model calculation to examine how it affects the income per hectare available to producers.

Producers can increase their available income per hectare in two ways: by maximizing the yield per hectare, and by maximizing the percentage of sugar content of the sugar beet. The effect of these two important indicators on income is demonstrated with simple model calculations (according to the basic contract of 2013)

a) The effect of the increase in the average yield at a fixed (16%) sugar content.
- In this case, the formula is very simple: every 0.1 t/ha increase in average yield increases the income per hectare (calculated with a base price of 26.29 EUR/t and a total premium of 10.71 EUR/t) by 3.7 EUR. Calculated at an exchange rate of HUF 300/euro, this corresponds to an income increase of HUF 1,110/ha.

b) The effect of an increase in sugar content with a fixed average yield
- In this case, the degree of influence of the examined variable is also influenced by the yield average and the sugar content interval. Therefore, we calculated the results for several scenarios, based on the 2008-2013 crop averages. To summarize the results, we can say the following (calculated at HUF 300/EUR exchange rate):
  i. In the case of an average yield of 49.63 t/ha (minimum of the years 2008-2013), an increase in sugar content of 0.1 percentage point results in an average increase of 3,433.05 HUF/ha (equivalent to an increase in average yield of 0.31 t/ha with a sugar content of 16%);
  ii. In the case of an average yield of 56.92 t/ha (2008-2013 average), an increase in sugar content of 0.1 percentage point results in an average increase of HUF 3,937.31/ha (equivalent to an increase in average yield of 0.35 t/ha with 16% sugar content);
  iii. In the case of an average yield of 67.79 t/ha (the maximum for the years 2008-2013), a 0.1 percentage point increase in sugar content results in an average increase of HUF 4,689.23/ha in revenue (equivalent to an increase in average yield of 0.42 t/ha with 16% sugar content).

In addition to the quality premium, producers can also receive a number of premium payments according to the contract. Among the premiums, there are permanent elements that are repeated every year (e.g.: logistics reimbursement, cleaning reimbursement, beet slice redemption fee), which continuously encourage the undertaking of the appropriate delivery schedule (e.g. compensation paid for delivery undertaken late or early in the campaign), the harvest guaranteeing adequate cleanliness the application of technology, or even the transfer of carrot slices for biogas production purposes.

Another group of premiums is included only from time to time, aimed at encouraging specific developments (technological development premium) or maintaining the circle of suppliers (loyalty premium, stabilization premium, technical development surcharge). In some years, the amount of the premiums can even reach 30 percent of the base price, so it is a tool with a significant economic impact from the point of view of both the sugar factory and the supplier.

Premiums for stabilization and technological development are primarily a means of retaining larger suppliers. In these farms, they typically think long-term about sugar beet cultivation, and have many special and expensive tools. The premiums listed here try to compensate for the costs of this long-term commitment.

In summary, it can be concluded that Magyar Cukor Zrt. incorporates a number of quality promotion tools into contracts, thanks to which a significant improvement was experienced in the average yield, average sugar content and sugar yield per hectare in the years under review.

15.1.4 Tools aimed at reducing logistics costs

The sugar factory now has far fewer tools to keep logistics costs under control. We have already mentioned the limitations related to transport distances. In addition to the given distance, reducing the logistics costs projected on the final product (white sugar yield) becomes even more important for this reason. To this end, the sugar factory stipulates in the contract the use of a suitable mechanical cleaning harvesting and stacking machine (cleaning reimbursement is a permanent premium related to this), and reserves the right to designate a sugar beet depot next to the sign.

The effect of the difference in sugar content on the cost of sugar delivery can be found in section 2. table, using the example of three transport distances.

Table 2. *Effect of the average sugar content on the value of the transport cost per white sugar mass*

Average sugar content		14,00%	15,00%	16,00%	17,00%	18,00%	19,00%	20,00%
Average white sugar yield content		12,10%	12,96%	13,82%	14,69%	15,55%	16,42%	17,28%
Distance	**Delivery method**	**Transport cost per mass of white sugar**						
25 km	Public road	5,23	4,88	4,58	4,31	4,07	3,86	3,66
90 km	Railwayery method	8,17	7,62	7,15	6,73	6,35	6,02	5,72
	Public road	15,40	14,38	13,48	12,68	11,98	11,32	10,78
236 km	Railwayery method	17,51	16,34	15,32	14,42	13,62	12,90	12,26

The table contains a model calculation that ignores the value of by-products. Thus, the nominal values included in it do not reflect the real cost content, but are suitable for estimating the relative differences. During the calculation, we used the simplifying condition that the average sugar content does not affect the specific mass of the sugar beet.

Under the above conditions, we can say that the change in sugar content results in significant differences in the transportation cost per weight of white sugar. The maximum value of the difference expressed in forints is HUF 1.57 per kilogram over a road distance of 25 kilometers, which already reaches HUF 5.25 per kilogram over a rail distance of 236 kilometers.

The two main problems of the organization of road transport are the distance on which the toll payment is based and the determination of the toll-paying mass. The latter is determined simply: the Company pays compensation for 108% of the acceptance (cleaned) mass. The producer must cover the additional costs resulting from a higher degree of pollution from his own pocket. The toll-paying distance between the table-edge depot and the sugar factory is established every year with the help of a satellite area survey, by determining the shortest route.

Another method of sugar beet transport is combined road-rail transport, which is used for road distances of over 90 kilometers. The first step of combined transport is to deliver the sugar beet to the railway loading station by road. In this case, the transport is also the responsibility of the producer, against the fee shown above. Magyar Cukor Zrt. is responsible for the cost of rail loading and transport from the loading station. The question is whether the inclusion of the railway makes the delivery of raw materials cheaper (and if so, by how much). On the example of transport from some highly important railway loading stations, the comparison is shown in table 3. can be found in the table.

It is clear from the table that rail transport is significantly cheaper over the already mentioned distance of 90 kilometers.

Table 3. *Comparison of road and rail freight charges charged to the Kaposvár sugar factory*

Loading station	Railroad distance to the sugar factory (km)	Ratio of the road cost to the rail cost for the same distance
1	236	197
2	109	143
3	263	201
4	158	184
5	234	175
6	188	150
7	94	188
8	202	178

15.1.5 Summary

In our study, we examined quality promotion and logistics cost reduction tools in the sugar beet procurement system of Magyar Cukor Zrt. Based on our results, it can be stated that the company uses the tools recommended in the international literature. The positive effect of the quality, technological and stabilization surcharges and premiums is clearly visible in the increase in the average yield and the sugar yield per hectare.

The premiums could reach up to 30 percent of the base price in the examined period, so they provide significant compensation to farmers who are committed to sugar beet cultivation in the long term, and also contribute to the implementation of further, specialized technological developments. At the same time, they did not provide enough coverage to reduce the extremely high supplier fluctuation during the period under review. The examined data suggest that the reduction of turnover and sowing area fluctuation will be achieved through increasing the size of suppliers.

However, the sugar factory has significant constraints in reducing transport distances, which account for the largest proportion of logistics costs: during the period under review, transport distances and, with it, specific logistics costs increased. This can be offset by the improvement of quality performance, as this can reduce the logistics costs for the final product.

15.2 Application of simpler decision support methods in procurement

In this case study, we can see some simple examples of the preparation of decisions aimed at the acquisition of logistics equipment.

A mineral water distributor would like to purchase electric pallet trucks for its newly built roll warehouse. The task seems simple, but two questions immediately arise:

ak) What should be the most important features (aspects) that play a role in making the decision?

al) How many alternatives should we include in our decision, and what should they be?

There are many ways to answer the questions. We can involve external experts, we can create a team of employees and managers already experienced in the subject, we can contact the various brand representatives and forklift distributors, we can find information on the Internet, we can order catalogs, etc.

For the sake of simplicity, let's assume that our experts don't want to overload us and instead collect the forklift data available from the catalogs.

For examples of forklift descriptions, see: https://www.jungheinrich.hu/fileadmin/minion/hu/tx_jhproducts_ffz/5365_hu-hu/assets/efg_110__113__115_t__puslap.pdf

15.2.1 Selection of evaluation criteria

Looking at the pdf file, we can see that the number of properties is quite large. The simultaneous inclusion of 20-30 available properties would make it difficult to use our methods. So we ask the experts to pick the six qualities that:

- *most affect* the efficiency and economy of warehouse work;
- *in addition,* they make it possible to differentiate the different types of forklifts.

The aspects are denoted by X_n, since we are not dealing here with states of fact that occur with different probabilities, but with "fixed" properties.

The six selected aspects are as follows:

- X_1*: load capacity (kg)*
- X_2*: turning radius (mm)*
- X_3*: travel speed with load (km/h)*
- X_4*: Battery operating time (Ah)*
- X_5*: net price (million HUF)*
- X_6*: reliability (failure, need for service, "durable" ability)*

In the case of the X_6, we do not have catalog data, which means that the evaluation of this aspect also awaits our well-established experts.

Since this property is not quantitative but measures quality, it was necessary to introduce a scale consisting of the following categories: weak; acceptable; average; good; excellent

15.2.2 Setting up the decision matrix

After that, there is no obstacle to rewriting the data of the original catalogs – similar to the example file – *into the decision matrix* containing our own aspects (see table 4).

The columns of the matrix represent the different aspects, and the rows of the matrix represent the *four alternatives* (that is, the four forklift types selected by the experts to be evaluated). The alternatives are denoted by S_n.

Table 4. *The decision matrix of the forklift selection task*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	2000	1550	4,5	160	1,88	Excellent
S_2	1500	1460	4,5	160	1,70	Average
S_3	2000	1595	3,6	210	1,61	Good
S_4	1500	1400	4,0	70	0,99	Acceptable

Now we have a table reflecting our own criteria, based on which we can run our procedures.

The values belonging to individual cells of the table will be denoted by xij, where the i in the index denotes the rows (alternatives), while the j denotes the columns (points of view). E.g. x14 = 160; x41 = 1500.

15.2.3 Application of elimination procedures

With this group of procedures, our goal is to reduce the number of alternatives, and not necessarily to find the only best solution. This seems less justified in the present example, since – for the sake of transparency – we only have a few alternatives. In real life, however, it happens that we have 10-20 alternatives, the number of which we would like to narrow down. The narrowing can be done on the basis of several philosophies (our starting point in all cases is table 16.4).

Satisfying (conjunctive) method

In this method, we establish an aspiration (or in other words: satisfaction) level for each aspect. The designation of the aspiration level is: $\mathbf{x^0_j}$, where j in the index corresponds to the index number of the given aspect.

In order to properly apply the aspiration level, it must be seen that in our table there are aspects for which the highest value is desirable *(aspect to be maximized)* and there are some for which the lowest value *(aspect to be minimized).*

✓ *The first group includes X_1, X_3, X_4 and X_6;*

✓ *the second group includes X_2 and X_5.*

The satisfaction level means a threshold, or the value below which (in the case of an aspect to be maximized) or above (in the case of an aspect to be minimized) we cannot accept the alternative.

Only those alternatives can remain, and those that satisfy all aspiration levels at the same time.

Mathematically stated:

S_i is acceptable if

✓ $x_{ij} \geq x^0_j$ *for all indices j, where the larger value is the better,*

✓ $x_{ij} \leq x^0_j$ *for all j indices where the smaller value is better.*

In this procedure, we get rid of all alternatives that could not fulfill even one aspiration level. A good example of this is the admission to the state examination, where the condition is that all subjects taken must be completed at least at a sufficient level.

Returning to our example, let's have our aspiration level x^0 = (1500, 1500, 4.0, 100, 1.80, avg).

Let's now compare this with the data of our decision matrix (Table 5)!

Table 5. *Elimination according to the conjunctive method*

	X_1	X_2 (min!)	X_3	X_4	X_5 (min!)	X_6
S_1	2000	~~1550~~	4,5	160	~~1,88~~	Excellent
S_2	1500	1460	4,5	160	1,70	Average
S_3	2000	~~1595~~	~~3,6~~	210	1,61	Good
S_4	1500	1400	4,0	~~70~~	0,99	~~Acceptable~~
X^0_j	**1500**	**1500**	**4,0**	**100**	**1,80**	**Average**

The values that do not meet the aspiration level have been crossed out (in the case of X_2 and X_5, the lower value is better!).

Looking at the table, we could also say that our filtering was "too good", since there was only one type of forklift (S_2) that did not have a crossed-out value in its row, i.e. that met the expected value for all aspects.

The choice of satisfaction level is of course in the hands of the decision maker, so if you want to keep more alternatives for the final decision, you can experiment with other threshold values.

Disjunctive method

We keep those alternatives *that are outstanding* in at least one of their properties. This approach can also be viable in company decisions similar to the present example.

The disjunctive procedure can therefore be given as follows:

✓ $x_{ij} \geq x^0_j$, j = 1 or j = 2 or j = m.

Be

x^0 = (2000; 1400; 4,8; 200, 1,0; excellent).

In this case, we have to cross out many more values in the matrix (see table 6).

In this procedure, the S2 alternative, which proved to be reliable in all respects in the previous point, falls out, since this truck alone did not meet any aspiration level.

Table 6. *Elimination according to the disjunctive method*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	2000	~~1550~~	~~4,5~~	~~160~~	~~1,88~~	Excellent
S_2	~~1500~~	~~1460~~	~~4,5~~	~~160~~	~~1,70~~	~~Average~~
S_3	2000	~~1595~~	~~3,6~~	210	~~1,61~~	Good
S_4	~~1500~~	1400	~~4,0~~	~~70~~	0,99	~~Acceptable~~
X^0_j	**2000**	**1400**	**4,8**	**200**	**1,0**	**Excellent**

15.2.4 Elementary decision-making procedures for finding the best solution

In the previous subsection, three methods narrowing the scope of our action options were presented. Continuing with the example we started, let's now review some of the procedures with which we strive to achieve the best solution.

Lexicographic method

The steps of the method are as follows:

a) prioritization of aspects;
b) selection of the best alternative based on the aspect deemed most important;
c) in the event of a tie in the second step (several alternatives are ranked first), the second most important aspect must also be included in the analysis;
d) in the event of a repeated tie, we continue the procedure with the next aspect, until only one alternative remains.

To test the method, we need the decision matrix again (see table 4)

Let's say the order of importance of the criteria is X_3, X_4, X_1, X_5, X_2. X_6 .

✓ The most important aspect is therefore the travel speed under maximum load, for which we have two best alternatives (S_1 and S_2).
✓ Because of the tie, we have to include the second most important aspect *(X_4)*, i.e. battery life per charge. Here - and for possible further steps - we only compare the two alternatives in the "competition". Unfortunately, we are still dealing with equality ($x_{14} = x_{24} = 160$).
✓ We must continue the comparison with the X_1 (maximum load capacity) aspect. The relevant values are $x_{11} = 2000$ and $x_{21} = 1500$, so the question is settled: *S_1 will be the best choice.*

Repeat the process with the following order of importance: X_5, X_6, X_1, X_2, X_4, X_3.

✓ In contrast to the previous case, we can immediately select the best alternative (S_4) based on the first criterion, since we have only one best value ($x_{41} = 0.99$).

It can be seen that the value judgment of the decision-maker greatly influences the outcome and results of the decision-making procedures through the establishment of the order of importance. The same is true for determining the aspiration level of the elimination procedures in the previous lesson.

It is important to see that different "optimal" results can be obtained depending on the individual decision-making procedures and also on the preferences of the decision-makers. From among the methods, the decision-maker must choose the one that is closest to his own decision mechanism "existing in his head" and value judgment.

Data quantification and transformation

Before we move on, we need to make a *short detour* in getting to know the methods for finding the best solution. The decision matrix used so far was excellent for our purposes, however, there are some obstacles to the application of the following two procedures.

In order to identify the obstacles, let's review the list of criteria once more!

✓ X_1: load capacity (kg)
✓ X_2: turning radius (mm)
✓ X_3: travel speed with load (km/h)
✓ X_4: Battery operating time (Ah)
✓ X_5: net price (million HUF)
✓ X_6: reliability (failure, need for service, "durable" ability)

Our difficulties related to the aspects are as follows:

✓ he units of measurement are not the same
✓ quantitative and qualitative criteria are mixed
✓ they are in the opposite direction (there are also parameters to be maximized and minimized)

The previous procedures *examined the aspects* one by one, separately, so these difficulties did not cause any particular problems.

However, in order to be able to *handle the values of the table at the same time and not grouped by aspect,* our matrix must be transformed (without distorting the information contained in the original data).

Let's start with the simpler task! The decision matrix contains a quality aspect (X_6, reliability), the verbal scale of which must be quantified.

During the process of quantification – arbitrary by nature – it is reasonable to ensure that

✓ the categories of the verbal scale representing better reliability receive the higher value;
✓ and the differences (value ranges) between the values of each category should be equal
✓ we carry out the transformation in a way that can be measured (scored) on a ratio scale.

Make the substitution as follows!

✓ weak 1 point
✓ acceptable 3 points
✓ average 5 points
✓ good 7 points
✓ excellent 9 points

The quantified decision matrix looks like this:

Table 7. *Quantified decision matrix*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	**2000**	1550	**4,5**	160	1,88	9
S_2	1500	1460	**4,5**	160	1,70	5
S_3	**2000**	1595	3,6	**210**	1,61	7
S_4	1500	**1400**	4,0	70	**0,99**	3

In the next step, we have to produce unit-independent (transformed) data, and moreover, in such a way that the parameters also become the same direction.

There are several methods to solve this, we are discussing one of them here, the process of which is as follows:

1. Selection of ideal values

The ideal value must be determined separately for each aspect. One possible way to do this is the *value given by the experts,* and another way is the *value extracted from the table.*

Let's choose the latter case! Then the ideal value

- in the case of aspects to be maximized, the maximum of the column of the given aspect (x_j^{max});
- in the case of aspects to be minimized, the column of the given aspect will be the minimum (x_j^{min}).

The ideal values of our example are marked in bold in Fig. 7. in a table.

2. Perform transformation

Denote the original data by x_{ij}, and denote the transformed data by r_{ij}. The way to calculate the transformed data is as follows:

a) For aspects to be maximized:
$r_{ij} = x_{ij} / x_j^{max}$ (that is, the transformed value is obtained by dividing the original value by the maximum of the column)

b) For aspects to be minimized:
$r_{ij} = x_j^{min} / x_{ij}$ (that is, the transformed value is obtained by dividing the minimum of the column by the original value)

We will not present the detailed calculations for this example. The final result of the transformation is included in 8. spreadsheet. It can be seen that after the conversion, the larger value means the more favorable for aspects X_2 and X_5, which previously represented the criterion to be minimized.

Table 8. *Transformed decision matrix*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	1,00	0,90	1,00	0,76	0,53	1,00
S_2	0,75	0,96	1,00	0,76	0,58	0,56
S_3	1,00	0,88	0,80	1,00	0,61	0,78
S_4	0,75	1,00	0,89	0,33	1,00	0,33

With this, rather modified, transformed decision matrix, we can confidently start the maximin and maximax method.

15.2.5 The pessimist and the optimist choice

The pessimistic decision maker (Maximin method)

The essence of the method is as follows:

- the decision-maker pays attention only to the elements of the table and considers the different aspects to be of equal importance;
- the values are transformed to a comparative scale;
- for each alternative, *the pessimistic decision* maker considers the *worst value* associated with the alternative as the weak link and prefers the alternative with the highest value among them.

Process of the method:

a) find the value mi = min {x_{ij}: j = 1,....,m} for all I = 1,..... n (that is, the smallest value of the row of all alternatives);

b) we select the alternative with the value max {m_i: I = 1,....,n) (that is, we select the maximum of the smallest values and the alternative that "records" the maximum value).

The minimums for the example can be found in 9. marked in bold in the table.

Table 9. *Selection of the minimums for the alternatives*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	1,00	0,90	1,00	0,76	**0,53**	1,00
S_2	0,75	0,96	1,00	0,76	0,58	**0,56**
S_3	1,00	0,88	0,80	1,00	**0,61**	0,78
S_4	0,75	1,00	0,89	**0,33**	1,00	**0,33**

Based on the table, we = (0.53; 0.56; 0.61; 0.33). The maximum of these is 0.61, i.e. the type marked with S_3 will be the choice of the pessimistic decision maker.

The optimistic decision maker (maximax method)

✓ The optimistic decision-maker considers only the best values for each alternative and prefers the alternative with the highest value.

Process of the method:

c) find the value $M_i = \max \{x_{ij}: j= 1,....,m\}$ for all I = 1,..... n (that is, the largest value of the row of all alternatives);

d) we select the alternative with the value max $\{M_i: I = 1,....,n)$ (that is, we select the maximum of the largest values and the alternative that "records" the maximum value).

The maximums for this example can be found in 10. marked in bold in the table.

Table 10. *Selection of maximums for alternatives*

	X_1	X_2	X_3	X_4	X_5	X_6
S_1	**1,00**	0,90	**1,00**	0,76	0,53	**1,00**
S_2	0,75	0,96	**1,00**	0,76	0,58	0,56
S_3	**1,00**	0,88	0,80	**1,00**	0,61	0,78
S_4	0,75	**1,00**	0,89	0,33	**1,00**	0,33

Based on the table, M_i = (1;1; 1;1,1). This means that in the current situation, based on the maximax method, the alternatives are equivalent for the decision-maker, since each of them is the best from at least one point of view.

In this case, the choice can be made using another method, such as weighted score calculation. However, we will present this using another example, a location selection task, in the next subsection.

15.3 Site selection using the weighted score method

We can choose the best according to our criteria from among the site alternatives given by the method. In order to apply the method, we must first collect the possibilities and be able to formulate the evaluation criteria.

Steps to apply the method:

1. collecting alternatives (site options);
2. definition of decision criteria;
3. assignment of importance weights to the criteria;
4. numerical evaluation of the alternatives according to the individual criterias;

5. determination of the weighted score of each alternative as the product of the numerical evaluations given to the criteria and the importance weights assigned to the criteria;
6. ranking the alternatives based on the weighted scores.

If the alternatives to be evaluated already exist, we must be very careful when choosing the decision criteria (also known as aspects) and determining the weights assigned to them. The decision maker has to choose which features to consider and which not to.

The key concept of the decision-maker's thinking is the *aspect.* Things have countless properties, but only a few of them are taken into account by the decision maker. These are none other than the considerations of the decision-maker. After that, the only question is what distinguishes properties from essential properties (aspects). This can be determined using the following two criteria, which must be met:

1. It has a distinctive role in the given decision-making situation.
2. The change of the given property significantly affects the usefulness of the alternatives compared to the change of the other properties.

The first criterion, the distinctiveness condition, is that the alternatives can be separated on the basis of the examined property. If, for example, we can choose between two cars of the same color when buying a car, then the two alternatives are the same from the point of view of color, so this feature cannot be important, nor is it an aspect in this way.

An example of the second criterion is the effect of a change in the price of a product. If the increase in the price of a product affects the outcome of the decision, then the price is an essential feature, therefore an aspect.

The usefulness of the properties is always relative, so it can be interpreted in relation to each other, on the other hand, it is subjective, because it always depends on the decision maker.

There is a procedure that can be used to narrow the range of aspects and determine the importance weights at the same time. Let's learn about this procedure through an example!

Let's say that an international fruit juice company is planning to build a new warehouse in Central and Eastern Europe. Several site alternatives are available for the construction of the warehouse in different countries of the region. The management of the company wishes to select the actual site carefully and during conscious planning. The first step in the selection process is to determine the attributes on which each potential site will be evaluated. The project team responsible for the expansion held a brainstorming session to determine the criteria. The following list of properties was created as a result of the brainstorming:

- „A": local fruit purchase prices
- "B": average road distance of site from potential producers,
- "C": the total installation cost of establishing a production plant
- "D": specific costs of utility services,
- "E": average road distance from current and potential customers,
- "F": level of transport infrastructure,
- "G": R&D capacities near the site,
- "H": tax burdens,
- "I": amount of labor,
- "J": cost of labor,
- "K": strictness of legal conditions.

It can be seen that, during the brainstorming session, the team collected 11 qualities that, in their opinion, are worth considering. However, this number is quite high. It is advisable to maximize the number of aspects at six. It is a question of which four properties to omit from the list of aspects. The selection is based on the relative importance of the individual properties. So we ask the project team to compare all possible pairs of properties in a table. If one member of a pair of attributes is judged more important than the other, that attribute should receive two points. In the event of a tie, one point is awarded to both attributes. The task can be easily done with the help of a table 11.

Table 11. *Determining the relative importance of properties by pairwise comparison*

Code	A	B	C	D	E	F	G	H	I	J	K
A		A2	A2	A2	A2	A1F1	A2	H2	A2	A1J1	A2
B			B1C1	B1D1	B2	B1F1	B2	H2	B2	J2	K2
C				C1D1	C2	C1F1	C2	H2	C2	C1J1	C2
D					D1E1	D1F1	D2	H2	D2	D1J1	D2
						E1F1	E1G1	H2	E1I1	J2	K2
F							F2	H2	F2	J2	F1K1
G								H2	G1I1	J2	K2
H									H2	H1J1	H2
I										J2	K2
J											K2

The filling "A2" in the intersection of row A and column B of the table means that the properties marked with A are more important than B, so property A gets two points. The marking "B1C1" found at the intersection of row B and column C means that the properties marked with B and C are equally important, so each property receives 1 point each.

The next step is to collect and sum up the total number of points which property received from the fields of the table. The total is entered in a new table, where the properties are listed in descending order according to the total score (table 12).

As indicated in the table, the six features with the highest relative importance score are kept as criteria (hereafter using the scores shown in the table as the importance weight), while the five at the bottom of the ranking are discarded.

Table 12. *A scoreboard of the relative importance of the features*

Code	Property name	Score
H	tax burdens	19
A	local fruit purchase prices	16
J	labor cost	14
C	the total installation cost of setting up a production facility	12
D	specific costs of utility service	11
K	strictness of legal conditions	11
F	level of transport infrastructure	10
B	average road distance of site from potential producers	9
E	average road distance from potential customers	4
G	R&D capacities near the site	2
I	amount of labor	2

In the next step, we create a table whose rows contain the selected aspects, its columns indicate the individual alternatives, and an additional column contains the importance weights (see table 13). The fields of the table include the evaluation of the alternative defined by the column according to the criteria defined by the row. The last row of the table contains the weighted scores of each alternative. Continuing our example, let's look at a table that contains the evaluation of three imaginary countries (alternatives A, B and C) according to the criteria defined above. The ratings were made on a scale from 1 to 5, where "5" means the best rating and "1" the worst rating.

Table 13. *Site selection using the weighted score method*

		Alternatives		
Viewpoints	**Weights**	**„A"**	**„B"**	**„C"**
tax burdens	19	4	1	3
local fruit purchase prices	16	2	1	3
labor cost	14	2	4	5
the total installation cost of setting up a production facility	12	3	3	4
specific costs of utility service	11	4	3	3
strictness of legal conditions	11	4	4	3
Weighted score		**260**	**204**	**289**

We have to multiply the evaluations given to site "A" by the weights for each aspect, and then add the values obtained in this way. So the weighted score for Site 'A' = 19 x 4 + 16 x 2 + 14 x 2 + 12 x 3 + 11 x 4 + 11 x 4 = 260.

It can be seen from the table that in our example the choice of country "C" is appropriate, since based on the evaluation of the decision-maker and the weights created by him, this alternative received the highest weighted score.

Bibliography

[1] Horváth, T., Csonka, A., Szerb, A. B. (2019) A minőség és a logisztikai költségek szerepe a cukorrépa beszerzésben. In: Bodnár, K. (szerk.) 5. Logisztika a Dél-Alföldön : Lektorált tudományos konferenciakiadvány. Csongrád, Magyarország : Agro-Assistance Kft. pp. 38–50.

[2] Cukorrépa Termesztők Országos Szövetsége (2004) Szakmaközi Egyezmény. http://www.ctosz.hu/uploads/documents/Szakmak%C3%B6zi_Egyezm%C3%A9ny.pdf, Letöltve: 2022. 09. 24.

[3] Cukorrépa Termesztők Országos Szövetsége (2010) Szakmaközi Egyezmény Módosítása. https://drive.google.com/file/d/14qQtj_Lvns-jquCALH3wDcdS8cdSTpNm5/view?usp=sharing, Letöltve: 2022. 09. 24.

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